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CONTENTS:

	PAGE
On the Telephoning of Great Cities	377
Electricity in Printing Offices	380
The Electric Light in Madrid	380
The Nature of the Sparks in the Electric Vibrations of Hertz (*illustrated*)—(*concluded*)	382
Electric Railways for Rapid Interurban Communication (*concluded*)	384
Measurement of the Light of the Electric Arc and of Some other Luminous Sources (*illustrated*)	386
Determination of Magnetic and Electric Current Work in Armatures (*illustrated*)	386
The Resolutions Passed by the International Congress of Electricians at Frankfort-on-the-Main	388
Some New Insulating Materials for General Electrical Purposes	389
Practical Photometric Research (*illustrated*)—(*continued*)	389
A Central Station Combining the Advantages of both the Continuous and Alternating Current Systems	391
Aird's "Doubly Secure" Tube Joint	393
Notes	393
City Notes, &c.:—Brush Electrical Engineering Company	397
Direct Spanish Telegraph Company	400
Priestman's Engine Company	400
City of London Electric Lighting (Pioneer) Company	400
Traffic Receipts	400
Share List of Electrical Companies	401
The Dynamos at Frankfort Exhibition—II. (*illustrated*)	402
New Patents	404
Abstracts of Published Specifications	405
Correspondence:—The Lighting of Railway Trains Electrically	406
Alternating Current Arc Lamps	406
Transformer Losses	406
The Telephoning of Great Cities	407

ON THE TELEPHONING OF GREAT CITIES.

OUR criticism of the British Association paper on the telephoning of great cities has brought us a letter from Mr. Bennett, which we publish in our correspondence columns.

Mr. Bennett's first care is to intimate that our criticism is worthless—not from any inherent defects, but in consequence of the source from which he supposes it must have been derived. He expected criticism, and was apparently very ingeniously prepared to show that wherever it might come from, it might be disregarded. We expressed the view that certain qualifications were necessary for those who would handle effectively the problem of telephoning great cities. Mr. Bennett puts it that we expressed the view that any one discussing the subject must possess those qualifications. This enables him to dispose of our criticism as worthless; because if it is editorial, it must be without knowledge; if not editorial, it must be criticism either emanating from the Post Office or from officials connected with the National Telephone Company. In either case it is worthless, because the Post Office has not any large exchange, and therefore has not the necessary knowledge; and the National Company are so hostile to anything that he may say, that it is only to be expected that they would criticise adversely and bitterly. Pursuing a similar line of argument, Mr. Bennett arrives at the conclusion that our article was inspired by the National Telephone Company. He is doing us a service by his frankness, but we would ask him to remember that our correspondence columns are open to the expression of opinions or information communicated to us by readers or subscribers, and that articles in our columns which are unsigned are the articles of the ELECTRICAL REVIEW. We fear that Mr. Bennett may consider we are assuming to ourselves somewhat miraculous powers, but he may accept our assurance that our editorial staff is quite capable of criticising Mr. Bennett without the inspiration of Mr. Bennett's *bête noir*. That our criticism was adverse in some respects was apparent. It can only have been bitter in its truths, for we have no reason whatever to criticise Mr. Bennett on other than the broad grounds of reason and of right, and we cannot but think that his obvious sensitiveness to criticism does not well accord with his own trenchant statements, of which some are not right, and others have no adequate reason.

Through an unfortunate series of misunderstandings, Mr. Bennett is under the impression that he is answering our criticism and correcting some of the numerous errors into which he thinks we have fallen. As these corrections arise entirely from mistakes of his own or perversions of our words, we might well let them pass without comment, except that they are accompanied by a good deal of invective, which gives them an air of reality, and makes it necessary that we should unravel them. We have to make an exception in respect to the grammatical error which is inexcusable, and for which we apologise.

Until we received Mr. Bennett's letter, we had no knowledge that the Mann system was ever under Mr. Morgan's thought. That he raised objections similar to ours shows nothing more than that he gave the matter some serious consideration. There is some difference, as Mr. Bennett will see if he refers to our article again. We expressly stated that the possible overhearing of numbers was not a serious defect. It was mentioned only as illustrating the truth of the statement "that perfection cannot be obtained by any one system." Mr. Bennett's exaggeration is alone responsible for our noticing that his own system was defective in one of his own prime requisites.

As we pointed out clearly, though briefly, the difference existing between the Law and the Mann systems, Mr. Bennett should not have permitted himself to make the statement that we were under the "delusion" that they were identical. If our explanation was incorrect, Mr. Bennett should have corrected it; if incomplete, he should have added to it. It is on such points as these he can render

service. He does no service to his cause or himself by using such words as "delusion," in the face of our own explanations to the exact contrary. The similarity which exists between the two systems was made no more of by us than was necessary to enable our readers to obtain a clear idea of the extent to which Mr. Bennett had permitted his listeners to be misled—as they obviously were misled.

Mr. Mann's invention may have been in use in England before the Law system. We do not know. It certainly was not in use in England before the Law was in use in America. It may have been an independent invention, but it is generally understood, and is described in an established text-book, which we quoted, to be a "modification of the Law system." It would probably be more easy to show that the Mann system was in use before it was invented by Mr. Mann than that it was in use in England before the Law was either practically used or experimentally demonstrated. In saying this we do not suggest that there was any absence of originality on the part of Mr. Mann in devising his modification, and we have already said that he is entitled to credit for an improvement in detail of practical utility. If Mr. Bennett will show us that more credit is deserved we will gladly give it.

Our comparison of the circuit wire telephone system with the circuit wire telegraph system is, to Mr. Bennett, "amazing." Conveniently assuming that we regarded the connection of telegraph instruments in series as characteristically American, Mr. Bennett proceeds to inform the editors of the ELECTRICAL REVIEW that Cooke and Wheatstone, and some others, did the same, which is certainly amusing if not amazing. The nonsense is on Mr. Bennett's side, and the sense on ours. There is some sense in our comparison, because one of the first uses of the telephone was its being placed in the office of subscribers to the district telegraph system with a direct wire to the central office. A special signal on the telegraph call was to be answered on the telephone. Prescott's "Telephone, &c." (Spon, 1879), says (page 46), "It [the telephone] can also be united with the district telegraph system so extensively developed here [America], and thereby the range of the latter system, which is now limited to a few special calls, such as police, fire, hack, &c., may be very much extended and improved." Whilst originally intended only for communicating to the attendant special calls not provided for on the telegraph dial, it very naturally grew into the coupling up of any two subscribers who had telephones so that they might speak to one another, the call coming through the telegraph instrument by means of the circuit wire. Mr. Lockwood, in a paper published a few years ago, wrote:—"The exchange system of the Law Telegraph Company was organised in the spring of 1875. It was the result of an idea of Wm. A. Childs, to whom is due the credit of working it up. This company operated in New York, and placed both a dial telegraph and a call bell and a Morse key and sounder at each subscriber's station. The dials and bells were on private wires, converging to a central station, and a number of the Morse instruments were in circuit together upon a call wire, also extending to the same central station—much the same in a general way as is the case in the present so-called 'Law' system. At the said central station was a switchboard and a set of trained operators to work the same. The call was sent in by repeating numbers on the Morse circuit."

If Mr. Bennett will but note that the only difference between the telegraph circuit wire, and the telephone circuit wire, systems is the substitution of telephonic for telegraphic apparatus, he will probably notice a stage in the evolution of the circuit wire telephone system, and will also probably conclude that our remarks had some pertinence and his have not.

The annunciator system, like other systems, was first applied to telephones in America, but existed elsewhere for other purposes. The signal system, though originating in America, has become universal by adoption. The circuit system has not. It remains characteristically American. Our definition is accurate, and Mr. Bennett's is not.

We did not assume that Mr. Bennett inferred the principle of numerous exchanges to be new. We simply stated it was not new, in order to add clearness to our brief exposition. Before Mr. Bennett's reasons for the concentration can be accepted, it will be necessary for him to show that the one we gave is wrong. Mr. Bennett in reducing apparatus increases operators. A telephone exchange is only one of many instances in which the multiplication of machinery reduces labour. The reasons he gives now for his divisions are the same as he gave in his paper, and the possible unwisdom of which we hinted at in our article, giving a quotation to point the moral. The instances we gave are as we gave them. We confined ourselves to actual facts.

Mr. Bennett states that he is twitted with differing from all other telephone engineers and managers, and that it is not true. We have no means, of course, of knowing how many may hold the same opinions as Mr. Bennett. We can only judge of their practice. The practice of the majority is exactly what we stated—contrary to Mr. Bennett on both the systems which he combines. But we quite agree with him that his comparative isolation is no proof of his being wrong. Our views are exactly represented in our criticism. "We think that in a scheme such as Mr. Bennett's a contradiction of established usage should be supported by good reasons." By good reasons we do not mean Mr. Bennett's assertions as to his standing alone before, and being copied since. We did not know that telephonic translators originated with Mr. Bennett—we fear there may be other claimants—and we do not know that any particular system of over-house work originated with him and is being copied by everybody else. All that he tells us on these subjects may be of considerable interest to the National Company and Mr. Bennett, but are of no interest to our readers or ourselves, except in so far as they and we desire that no one should be denied the credit which is his due. These references to Mr. Bennett's past history with the National Company may do very well in the columns of the *Times*, but they are out of place in the ELECTRICAL REVIEW, when some totally different point is under discussion, the solution of which they in no way help.

Mr. Bennett's reply to the fault we found with his tabular comparison is very unsatisfactory. He places on Mr. Poole the responsibility of the enumeration of the "American" system, and having selected an expert for the purpose he reduced his figures by two, claiming credit for doing so. It seems to us it was Mr. Bennett's duty to place facts before

the British Association, and if the movements were eleven, they should have been so stated. We think Mr. Poole was right. His figures prove exactly what we said—that many of the operations were counted as one on both sides which should be counted as two. We are sorry to say that whilst Mr. Bennett has furnished us with a proof of his inaccuracy, he cannot be accorded the credit for moderation which he claims. The addition of two on the one side would probably have added—or shown the necessity of adding—two on the other, and so the proportion be materially altered. Mr. Bennett says we alleged that two movements on the "American" plan should be counted as one, because they are only equal to one on the "Mutual" plan, and that we must know that an intermediate movement renders them separate operations. He thinks such an objection in the highest degree disingenuous, and calculated to deceive. We are completely in accord with Mr. Bennett in that opinion, and we think, also, that a reference to our article will show that his representation of our objection is in the highest degree ingenious. We said that "sufficient care should have been exercised in revision to prevent the counting as one operation on his own side of that which is given as two on the other." Not only did we not allege what Mr. Bennett says we alleged, but we made it perfectly clear that the equalising method that should be adopted was not the reduction on the left of two into one, but the increase on the right of one into two. There is no difficulty, real or imaginary, in doing this, and it is the correct method. We gave Mr. Bennett the benefit of the suggestion that his error arose from want of care. In reply, he perverts our words, raises a question of "experience" on an imaginary difficulty, and concludes with the words "disingenuous" and "deceive." A frank avowal and prompt correction of the mistake would have involved much less trouble, and placed Mr. Bennett before our readers in a better light.

As to the methods of comparison: what we claimed was that in a paper read before the British Association a comparison should be made in a form which the members may take to be correct. If, to obtain this, the creation of a new unit is necessary, it should be created. But the necessity does not exist. The members of the British Association understand decimals. If they are told that something weighs a certain number of pounds, they cannot be expected to know that some of the pounds are equivalent to sixteen ounces and some to less.

We did not make the "palpable mistake" of saying that continental exchanges would have to be reconstructed, in order that London subscribers might communicate with them. We intimated that, instead of being facilitated, it would be rendered difficult, unless the systems were identical. The simile we adopted, by way of comparison, like most similes, will not bear being pulled to threads; but it represents, with reasonable accuracy, the relative positions. The break of gauge on the Great Western Railway did not render it impossible for passengers or goods to be carried from Edinburgh to Exeter, but it interposed difficulties which naturally, though gradually, led to its alteration to the prevailing gauge. Argument on detail is possible on both sides, and no doubt Mr. Bennett could prove to his own satisfaction that he is right; but we do not think he will succeed in overthrowing the broad principle that inter-communication is facilitated by similarity, and rendered more difficult by dissimilarity, of systems. But perhaps we were incorrect in assuming that he claimed any facility for his system beyond that given by return circuits. In which case he is, of course, right, since return circuit wires for such purposes go without saying.

In the end as in the beginning, Mr. Bennett sees a National ghost. Mr. Bennett is entirely wrong. We gather from the sources of information to which Mr. Bennett refers that if there are any recent developments they have not, as he says, worked many miracles. We would like to see something of them and hear some things better by them. But Mr. Bennett must not jump to the conclusion that they exist on the strength of our reference to "later developments." We simply referred to some advantages of detail which he implied were only to be obtained in the system he advocated. Some of these, pointed out by Mr. Gavey in the discussion, were not withdrawn—though referred to—in Mr. Bennett's reply, and reappear in his letter.

The expense of the central office apparatus dispensed with, and the subscriber's apparatus added, we did not specifically refer to. It is a point of too great detail to be gone into in such a criticism, and is included in our observation that "the question of economy has to be considered, not in one detail, but in all." We did not understand that Mr. Bennett did without the service wire. We understood that he might possibly do so, and it occurred to us that it is sometimes preferable to bear the ills we have, than fly to those we know not of. Mr. Bennett's denial of our statement that the absence of electro-magnets is common to both systems, shows that he does not peruse our columns with the diligence he should, or he would have noticed that we had recently to claim for the English Post Office the credit of the bridging system used in America, as elsewhere, to a degree which entitles it to be considered common. His question as to service wire was answered by anticipation, when we said "it is quite conceivable that, for communication between exchanges, methods may be adopted which are not applicable to ordinary subscribers."

Mr. Goodwin's letter contained one or two practical points which might have been replied to, but Mr. Bennett prefers to confine himself to the one of least importance, since it was corrected by our exposition of the two systems in the same issue as the letter appeared.

We do not think we have omitted to correct any of the statements made by Mr. Bennett which are important enough to need correction, though there are several interpolated remarks which might be profitably enlarged upon, had we not already found it necessary to occupy so much space in putting right the points which Mr. Bennett, with considerable cleverness, has succeeded in putting wrong. If there are any inaccuracies in our corrections, we shall be glad if Mr. Bennett will tell us so, remembering when he does so that our only object is to give our readers correct views on a somewhat intricate subject, which may be easily obscured if too much reliance is placed on one "prolonged practical experience," without reference to the fact that there are practical experiences more prolonged and more extensive.

For our criticism we claim no more than can be claimed for Mr. Bennett's paper. It is worth much or little in proportion as its facts are facts, and the conclusions reasonably

drawn from them. Being no advocate of systems or individuals, we shall gladly welcome any information tending to give our readers an opportunity of judging for themselves.

In suggesting that his paper encountered rough handling in our criticism, or that our remarks were in any way unkind, Mr. Bennett is, we think, under a misapprehension. His paper was not remarkable for any attitude of gentleness to those who happened to differ from his views. He must know that had we desired to handle it roughly we could have done so, and that in confining our remarks to just so much as was necessary to raise grave doubts of the success of his panacea for all telephonic ills, we were exercising considerable moderation, and doing no more than it was our duty to do under the circumstances with which it was surrounded.

ELECTRICITY IN PRINTING OFFICES.

THE electric lighting of printing offices, and especially of the composing rooms, has not been so largely adopted as might be desired. It is only those who have occasion to work in such establishments by night who thoroughly appreciate the superior advantages of electrical illumination over gas lighting. Illegible manuscript, bad sub-editing, and scarcity of sorts, are only a few of the troubles of the compositor, but when he has to perform his task under a half-power gas jet, with a sickly light, thrown, perhaps, on a few of the larger boxes, he frequently wishes that he had never become a type lifter. Moreover, in some printing establishments, from the manner in which the gas pendants and jets have been erected, it has seemed as if the gas fitter intended that the rays of light should not be concentrated upon the spot desired to facilitate setting but rather diffused over a given and unnecessary area.

It is, however, fortunate for many of the London printers and also for some in the provinces, that electric lighting has been introduced in a manner which seems to be fairly satisfactory. At first the men, and especially the old hands, had no faith in the new illuminant; but when they found that they had a steady light, one which did not increase the temperature of the room or give off the fumes which obtain with a gas jet when a whiff of air passed through the ventilators, then they welcomed electricity, not only as a working aid, but also as a preservative of health. As already mentioned, in the Metropolis, and also in certain provincial towns, the electric light has been beneficially adopted, but a great deal still remains to be done.

It is not only in the case of lighting, but also in the operation of the printing machinery that a field is open. In a few—a very few—isolated instances in the provinces electric-motors have been used for driving the presses; but there is no reason why these should not become general in all electrically lighted printing establishments, and, in fact, in those which are not so illuminated.

The disinclination to the employment of electric-motors for printing and other purposes appears not to be due to the belief that they are unable to perform good work, but that gas or steam engines being already installed it is therefore useless to incur additional expense when the present means of producing power suffice; when, however, the latter have reached the limits of useful work, they will doubtless be superseded by electric-motors in the case of old firms, and be adopted in lieu of steam or gas engines in new works, especially where the latter are in the neighbourhood of electrical distribution from a central station.

THE ELECTRIC LIGHT IN MADRID.

IT is a curious and interesting fact to electricians that the electric light can now be supplied in Madrid at a cheaper rate than either petroleum or gas. The last number of the *Revista Minera* contains a long article on the subject, in which the cost of each is fully gone into, particulars being given both as to the reason of the high price of petroleum in Madrid, as compared with other places, but more especially London, and to the cost of production, and of the materials for producing, gas and electric light.

The article recommends, therefore, the adoption of the electric light in Madrid, in preference to its competitors, petroleum and gas — not on account of its illuminating power or its convenience, but because of its economy!

Quoting briefly from the article, the cost of petroleum and gas in Madrid and London, respectively, are as shown in the following table :—

	Madrid.	London.
Petroleum	85 centimos per litre or, say 5d. per pint	16 centimos per litre, 1d. per pint.
Gas	40 centimos per cubic metre or, say, 9s. 4d. per 1,000 cubic feet	13 centimos per cubic metre, 2s. 9d. per 1,000 cubic feet.

The cost in Madrid of a petroleum lamp of 10 C.P., burning five hours per day, is about 4s. 3d. per month, while the electric light, based on the same rate as that charged in London, namely, 7d. per unit, would amount to about 3s. in a similar period, and for an equal illuminating power.

Mr. Hemas, the writer of the article under notice, in commenting upon the distribution of electricity, considers that it is not possible to take the example of the distribution of gas over a large area from a large gas-making establishment, and apply it successfully in the case of the electric light. Rather than erect large electric supply stations to meet the demands of a large and extended district, as is the general practice in this country, he considers that a number of small stations capable only of meeting the demands of a more restricted area, would have a much better chance of success, and would prove a much more serious competitor to gas, since, as he affirms, the cost of production would be greatly reduced.

Another Pure Water Primary Battery.

A French patent of Marceille and Ferret dated September 12th, 1859, No. 42,102, describes and illustrates a galvanic battery consisting of an exterior vase containing a carbon cylinder, enclosed itself in a porous vase. Around the latter is an iron plate which is immersed in pure water, while the carbon is immersed in sulphuric acid diluted with water. A correspondent who has kindly placed the above information at our disposal considers it remarkable that the U.S. Government should have granted a patent to D'Humy with a broad claim for a battery with an iron electrode in pure water, when such an element was anticipated by at least 10 references of earlier date, some of which have appeared in our columns. This, says our informant, does not speak well for the U.S. patent system, and shows that examinations made by the U.S. patent office to ascertain novelty of invention are superficial and inconclusive. Our correspondent is an opponent of the American patent system because long experience has shown him that no examiner can make an exhaustive search among the materials placed at his disposal. For example, there are, he says, at least 500,000 European patents (in different countries) which have never been printed and the U.S. Government has no way of making searches among them. Still the law regards such specifications as a statutory bar to the granting of a patent, and when granted to the validity thereof.

High Speeds.

High speeds seem to be the order of the day. We find it stated that in America, on the 19th of last month, a steam launch, the *Norwood*, made a run of 14 miles in 32 minutes, a part of the trip being made at "a rate of one mile in 30 seconds" (*sic*) *i.e.*, 120 miles an hour!! We also hear that a locomotive of the Wotten model ran one mile in 39½ seconds, 10 consecutive miles being made at an average speed of a mile in 43 seconds; one mile thus being run at the rate of 90·45 miles per hour, and the 10-mile run being done at the rate of 83·72 miles per hour. The feat was accomplished with a train of three cars, the ordinary passenger coaches, and a heavy private car. Provided weight can be reduced, there seems no reason why the speed attained should not be increased, though the expense of the running may make the commercial value doubtful. The use of aluminium will probably largely help towards the object, and electrical driving would seem to be almost indispensable.

An Electrical Method of Determining the Molecular Weights of Metals.

The molecular weights of a large number of metals have recently been determined by Herr G. Meyer by an interesting method, which shows how closely all branches of science are related and how inter-dependent upon each other they are. The method consisted in measuring the electromotive force of cells containing two amalgams of the metal in question, of different concentration, as electrodes, and a salt of the metal as electrolyte. If E is the electromotive force measured, the molecular weight of the metal may then be calculated by means of the equation

$$M = 1{\cdot}1908\ q\ T/E \times \log_{10} c_1/c_2$$

where c_1 and c_2 are the concentrations of the two amalgams;
„ q is the electro-chemical equivalent of the metal;
„ T is the absolute temperature.

This method, although quite a recent one, is not due to Meyer. It was first proposed by V. von Türin in the *Zeit. Physikalische Chemie*, v., p. 340, about a year ago, who at the same time proposed another electrical method which seems much simpler. This method consists in measuring the electromotive force of a simple galvanic cell, in which one electrode is formed of pure mercury and the other of an amalgam of the metal, the molecular weight of which is being determined, the electrolyte being a mercury salt either in solution in water or alcohol, or in the molten condition. In this case, if we have two vessels, A and B, of which the first contains pure mercury and the second the amalgam, a cycle of changes may be performed by transferring osmotically a certain small quantity of mercury from A to B, and then connecting A with B electrolytically, and thus allowing the mercury to be returned to A. The work done in each of these stages is, of course, the same, and is measured by the product of the electromotive force into the amount of electricity, which is necessary to transfer unit weight of mercury from A to B, the latter being inversely proportional to the electro-chemical equivalent of mercury. The function may then be found which expresses the relation between the unknown molecular weight and the electromotive force of the cell. This method is evidently similar to the one used by Meyer, but it differs from it somewhat in being somewhat less complicated and less difficult to treat. The details of Meyer's work are given in the *Zeit. Physikal. Chem.*, vii., pp. 477—484.

The Electrical Conductivity of very Dilute Copper Sulphate Solutions.

About a year ago in a paper on the heat of dissociation and the influence of temperature upon the dissociation of electrolytes, S. Arrhenius showed that the conductivity of electrolytes must reach a maximum as the temperature increases, and that when this maximum is attained the conductivity at once begins to fall. This work was really a deduction from the dissociation hypothesis, and was held by Arrhenius to be an additional confirmation of it. The experimental results and the mathematical reasoning employed in interpreting them were very interesting, and may be read in the *Zeit. Physikalische Chemie*, iv., pp. 96—116. Experimental confirmation of the theoretical conclusions was obtained in the cases of hypophosphorous and phosphoric acids, but owing to the difficulty of determining the conductivity at high temperatures, no further confirmation has, up to the present, been obtained. Recently, P. Sack has been at work upon this obscure question, and has been specially devoting his attention to the determination of the maximum conductivity of very dilute solutions of sulphate of copper. He has succeeded in determining the conductivity of these solutions at temperatures up to 120° Centigrade. The solutions were contained in a sealed apparatus, so that any change of concentration owing to evaporation might be avoided. The strength was varied in three separate cases:

	Copper Sulphate.
Solution A	0·327 per cent.
„ B	0·500 „
„ C	0·640 „

Measurements were successfully obtained with each of these solutions, and the conductivities were observed to reach a maximum at the following temperatures:

Solution A	94° Centigrade.
„ B	95° „
„ C	96° „

From the dissociation theory it can be shown that the conductivity at any temperature, λ_t, is equal to

$$\Lambda_1\, \varepsilon^{-bt}\, (1 + a\, t)$$

Where Λ_1 represents the amount of dissociation at the temperature, t_0, where b is constant, and where a is the temperature coefficient. The function λ_t becomes a maximum when $(1 + a\, t)\, b = a$, so that above the temperature the conductivity decreases, that is the temperature coefficient becomes negative. But when Sack calculated the temperature of maximum conductivity for the third solution by means of the above formula, which is due to Arrhenius, he found that it was 99° instead of 96°, which indicates some discrepancy somewhere. Sack's work may be consulted in the *Annalen der Physik und Chemie*, series 2, Vol. xliii., pp. 212—224.

THE NATURE OF THE SPARKS IN THE ELECTRIC VIBRATIONS OF HERTZ.*

BY ED. HAGENBACH BISCHOFF AND L. ZEHNDER.

(*Concluded from page* 362.)

IN our experiments either the primary and secondary conductors were placed free at different distances opposite to each other, or they were placed in the focal lines of the parabolic cylindrical mirrors of sheet zinc, diverging 6 metres from each other, these mirrors having the same dimensions as those used by Hertz. In each case the character of the phenomenon was essentially alike, only the intensification by means of the mirrors was distinctly manifest, since when they were used the phenomenon was as distinct at a distance of 6 metres as it was at 1 metre without mirrors. The greatest distance at which we could institute definite measurements without the mirrors was 2·35 metres.

We will first discuss the observations on the tensions or potential differences. For their measurement Thomson's well-known quadrant electrometer, constructed by Carpentier according to the design of Mascart, was used. It was sometimes used so that a constant charge was given to the aluminium needle, and the two halves of the secondary conductor were connected with the quadrants (in which case a potential difference of 1 volt in the quadrants gave a deflection of six divisions on the scale) or the quadrants were charged by a constant battery, and the aluminium needle was connected with the one-half of the secondary conductor, in which case 1 volt gave a deflection of only 12 divisions. The former method was more favourable, perhaps in consequence of its more symmetrical arrangement, in so far that the sparks sprang over at greater distances; the second had the advantage that the two halves of the secondary conductor could be examined separately.

In all experiments made with the electrometer, deviations occurred as soon as sparks were observed striking over in the spark-interval. Whilst, as we have already seen in case of the primary sparks, the electricity always passes over in the same direction in the secondary conductor, the sparks pass sometimes in one and at others in the opposite direction. To this view we are compelled by the appearance of the rounded ends of the platinum electrodes, as the figures formed by oxidation on both sides are exactly alike; as our endeavours to recognise any difference remained fruitless, we may admit that on the average approximately equal quantities of electricity pass in each direction. When the distance of the electrodes in the secondary spark interval was so arranged that the sparks sprang over regularly, the following phenomenon appeared on reading off the electrometer, introduced according to the first method. As soon as the main circuit was closed, the interrupter came into action, and the primary sparks passed over briskly, there appeared also small, but distinctly visible, sparks in the secondary spark-interval, and at the same time, there was observed a distinct deviation which took very different values according to circumstance. This deviation, however, was by no means constant, but the needle vibrated to and fro from 10 to 20 degrees and more. We therefore determined only the mean values of the deviation; in order to obtain them better, the electrometer was damped by means of a small piece of platinum foil moving through the sulphuric acid.

In general the needle was the quieter the more regular the play of the interrupter and the more uniformly the sparks sprang over, which could be especially recognised by the manner of hissing and crackling of the primary sparks.

As long as the induction apparatus is active this varying deflection remains about at a mean value. But as soon as the current leading to the inductorium is interrupted the needle undergoes a quite constant deflection (quite independent, both in magnitude and deflection, of the former fluctuating deflection), and which, under some circumstances, may extend beyond the scale, and which answers to about 40 volts. Thus it happened in one of our experiments that as long as the inductorium was active the deviations to the right varied from 10 to 20 divisions of the scale, whilst on interrupting the main current the needle passed to the left side more than 200 divisions, *i.e.*, beyond the scale, and only returned to a position of rest very slowly, corresponding to the loss occasioned by imperfect insulation.

In order to understand this phenomenon we must, above all things, consider that the time—during which the primary spark springs over and the electromotive forces, $+e-e$, are active—is vanishingly small in comparison with the interval of time between two successive sparks. In the deflection of the needle only those charges come into consideration which the electrometer possesses in the intervals of time between two successive primary sparks.

We must, therefore, first examine how and under what conditions the electromotive forces induced by a primary spark may charge the halves of the secondary conductor and the electrometer which is placed in connection with it. In the accompanying diagram, I is the primary conductor, II the secondary conductor, and 2 the quadrant electrometer. In the primary spark interval, F, we allow the spark to spring from above downwards, in consequence of which, in the secondary spark interval, *f*, the positive electricity is first driven by $+e$ from below upwards, and then immediately afterwards by $-e$ from above downwards. This last propulsion is assisted by the charge which has already arisen by the action of $+e$. If, therefore, $+e$ has already effected an over springing, $-e$ will the more readily cause a spark to spring over in the opposite direction, and this the more readily as the interval has become better conductive by the passage of the first spark, and thus, in a manner, the way is prepared for the second spark, which follows immediately in the opposite direction. Consequently the positive electricity, quite independent of the magnitudes of $+e$ and $-e$ will pass more easily in the secondary conductor from above downwards than from below upwards.

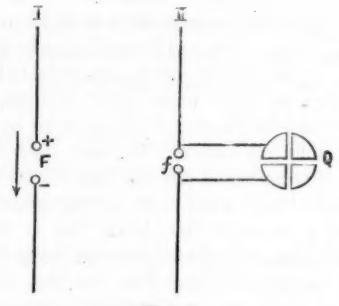


FIG. 5.

Each primary spark occasions, therefore, a charge of the electrometer by means of the two electromotive forces, $+e$ and $-e$, which are induced in the secondary conductor in rapid succession; the magnitude and the sign of this charge may vary greatly from spark to spark according to circumstances. If the upper half of the conductor is found charged positively, we may conclude with certainty that $+e$ was greater than $-e$ and could therefore more easily overcome the spark interval. On the other hand, it does not necessarily follow from the positive charge of the lower half that $-e$ was greater than $+e$; it may be due to the circumstance that from the grounds above-mentioned the positive electricity passes more easily from above downwards than in the reverse direction.

In order the better to observe these charges induced by a single spark we removed the interrupter from the inductorium, merely interrupting a mercurial connection by hand and observing the deviations thus produced at the electrometer. In this manner we obtained deviations of different magnitudes and varying quite irregularly, now to the left and now to the right. This was easy to understand, as the strength of the current of the primary spark must be modified in the most manifold ways in consequence of the interruption of the main current, which is never quite alike, and of the changing resistance in the spark interval. Hence no regularity could be expected from the electromotive forces in the secondary conductor. It would be scarcely remunerative to seek up the decisive causes for each single case.

We turn now to the ordinary case where not only a single spark passes over, but the interrupter comes into play and

* *Repertorium der Physik.* Vol. xxvii., p. 496.

the interruptions follow each other rapidly. In this case every primary spark passing over modifies by its inductive action the charge of the secondary conductor and of the electrometer in connection with it. The power acting upon the needle remains therefore constant only during the brief interval of time from one spark to the next, assuming then a value which may be greater, smaller, or antagonistic. As the interval of time between two sparks is in any case very small in comparison with the time of the oscillations of the needle, it cannot follow the impulses, which vary from spark to spark, and which are sometimes larger, sometimes smaller, and which come now from the one side and now from the other. It falls into irregular fluctuations, and its mean position will show whether in the resulting action, which we may call the action of difference, any definite direction preponderates. Not until the current is interrupted does the charge just then existing reach its full significance and effect a constant deflection of the needle.

We could thus measure two distinct things, either the mean position of the vibrating deflection during the play of the interrupter, or the constant deflection at the moment when the main current is interrupted. We shall first discuss the latter.

For measuring the constant deflections we connected the electrometer according to the second method, allowed the interrupter to act for a few seconds then suddenly interrupted it and brought the needle in connection as rapidly as possible, first with the one and then with the other half of the insulated secondary conductor, and read off the corresponding deflections. Several series of observations were instituted, and we give in the following table, by way of example, the readings for nine such experiments made in succession with the use of the parabolic mirrors.

Deflection in divisions of the Scale.

Upper half of secondary conductor.	Lower half of secondary conductor.
+ 22	− 34
− 47	+ 41
− 40	+ 25
− 21	+ 15
− 37	+ 34
− 22	+ 17
+ 21	− 26
+ 2	− 10
− 17	+ 13

As was to be expected, the two halves in one and the same experiment, always exhibit opposite signs; that the deviations on both sides were not exactly equal is evidently due to the varying losses in consequence of the insulation, which, in spite of every precaution, was not quite perfect.

In this series of experiments the negative values predominate in the upper half, and are in the mean larger. Hence more positive electricity passed from above downwards than in the opposite direction. In another series of 20 experiments the result was similar but in a less degree. We will, however, not draw from this fact any general conclusion, as the following experiments can inform us better whether, and under what conditions, a given direction of discharges predominates on the mean in the secondary spark-interval.

We turn now to the consideration of the fluctuating deflections which continue as long as the interrupter is in action. Here, as we soon observed, the size of the spark interval is decisive. In order to examine this influence more closely, we placed the electrodes at first so far from each other that no sparks could pass, and we then, at short intervals, approximated them gradually to each other up to complete contact, and thus obtained deflections corresponding to spark-intervals of different sizes.

We give three such series of observations carried out with the use of parabolic mirrors; + denotes that the upper half of the secondary conductor was charged positively, and that, consequently, more positive electricity passed in the direction to which + e impels; − denotes the opposite condition.

Spark interval (μ) on micrometer.	Mean deflection in divisions of the scale.		
20		+ 107	+ 12
18	+ 114	+ 79	+ 160
16	+ 71	+ 48	+ 63
14	+ 51	+ 26	+ 50
12	+ 5	− 7	+ 1
10	− 17	− 15	+ 5
8	− 13	− 21	− 19
6	− 21	− 50	− 21
4	− 14	− 29	− 20
2	+ 1	− 15	− 7
0	0	0	0

In the large spark intervals down to about 16 μ, the fluctuations were very great, in accordance with the circumstance that the play of the sparks was not uniform, but occasionally interrupted.

A perfectly regular movement in the figures is here not to be expected, as we have here to do with the total action of a great number of different charges, the magnitude and the signs of which vary continually and depend on all possible conditions. We may here add that the modification which the spark interval undergoes during use chiefly by oxidation interferes to an important degree with the result, and that in consequence before every series of experiments the rounded ends of the platinum wires on both sides should be most carefully cleansed. Still, a regularity in the above series of numbers cannot be ignored. In the larger spark intervals more positive electricity passes over from below upwards, *i.e.*, in the direction of the current occasioned by + e; at a distance of about 10 μ, about an equal quantity passes in both directions, and at smaller spark intervals the transit of positive electricity from above downwards preponderates. This is easily explicable according to the considerations laid down above, if we assume that in the mean the tensions + e are rather greater than the tensions − e, whence the primary spark arises more rapidly than it disappears. In the larger spark intervals, in consequence, the + e more frequently reach the magnitude necessary to overcome the resistance than the − e, whilst in small spark intervals both the + e and the − e are able to overcome the resistance, and as we have seen the electricity driven over by + e, flows back in part with the current occasioned by − e.

We turn now to the measurements of the strengths of current in the secondary conductor; for this purpose a Wiedemann galvanometer of about 15,000 turns was used, so thoroughly astatic that a current of 10^{-8} amperes gave a deflection of 3° of the scale. During the observation the galvanometer was connected sometimes with the inner and sometimes with the outer ends of the halves of the secondary conductor; no decisive difference was found. We content ourselves, therefore, with communicating the results obtained according to the accompanying diagram, where the galvanometer is connected in a manner precisely similar to that in the case of the observations with the electrometer, and forms a by-circuit of the spark interval, *f*.

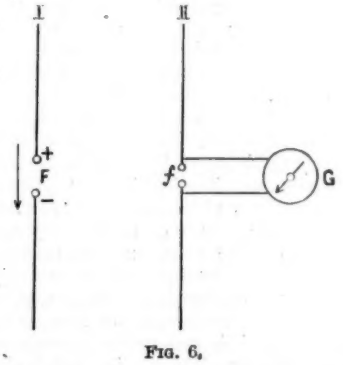


Fig. 6.

It may seem strange that sparks should appear at all here, so long as the two halves are in conductive connection with each other. But we saw in the experiments with the induction current of the Ruhmkorff apparatus that a galvanometer attached as a by-circuit to the spark interval shows currents as soon as the sparks spring over. Here, also, an action might be expected, although the conditions are different in so far as we have to do with two insulated halves. Even when a short conducting wire forms a by-circuit to the spark interval the play of sparks still goes quietly on, a phenomenon to which Herr Waitz calls attention (*Wiedemann's Annalen*, Vol. xli., p. 435), and upon which we had come whilst arranging our experiments before we had received his work. This phenomenon is intelligible only if the electromotive forces, e, increase in an exceedingly short time, as we are also compelled to assume from other reasons.

The action upon the galvanometer is easily understood from the following consideration:—The entire system of the secondary conductor is insulated, whence upon the whole as much electricity must flow from the lower to the upper half

as from the upper to the lower. Now, if more positive electricity passes through the spark interval from below upwards the same excess passes through the galvanometer in the opposite direction. We can therefore conclude from the deflection of the galvanometer needle as to the direction in which the excess of the positive electricity passes in the spark interval. In the galvanometric observations we studied the dependence of the deflection on the size of the spark interval, and we give, as example, the three following series of observations with mirrors whereby the + sign indicates that an excess of positive electricity passes from below upwards in the spark interval.

Spark interval (λ) on micrometer.	Mean deflection in divisions of scale.		
22	+ 4	+ 2	
20	+ 4	+ 6	+ 2
18	+ 7	+ 17	+ 3
16	+ 13	+ 24	+ 15
14	+ 27	+ 28	+ 25
12	+ 28	+ 28	+ 37
10	+ 27	+ 27	+ 42
8	+ 22	+ 15	+ 39
6	+ 4	− 4	+ 18
4	− 2	− 3	− 2
2	− 3	− 2	− 12
0	0	0	0

These results agree mainly with those given by the electrometer; at larger intervals more positive electricity passes in the direction to which the electromotive force, + e, impels it, and at smaller intervals more in the opposite direction. In the galvanometric experiments the negative signs are less prominent. This, however, is by no means universal, as in other experiments, especially in those without the mirrors, the negative deviations predominated.

In our considerations we have assumed that only a single primary spark passes over, whilst we have pronounced it probable that the spark is decomposed into a number of partial discharges. It is easily seen that in this case the same conclusion must essentially hold good since we can apply the above considerations to every partial discharge, and the great diversity in the action of the several sparks will become more easily intelligible.

In the secondary spark interval also, if it is short, a further decomposition of the small spark into single partial sparks may occur and thus further complicate the process.

From the manifold experiments which we have made, of which we have particularised only a few examples, it appears to us, above all, that the secondary sparks elicited by induction are of a quite different nature from the primary sparks. In each discharge which takes place in the same direction in the primary spark interval, there correspond two discharges in the secondary spark interval, following each other immediately, in the two opposite directions. Of these, sometimes the one and sometimes the other preponderates, since both the origin and disappearance of the primary spark, exposed to all manner of contingencies, and the nature and length of the secondary spark interval have a determining effect. By means of the well-known law of induction we may fully account for the essential character of this very complicated phenomenon, though it is perhaps not possible to pursue the process with calculation into all its individual characters. But its diversity can scarcely be explained, if, with Hertz, we regard the primary sparks as simple, perfectly homogeneous vibrations, whose energy, according to the views of Maxwell, is propagated through the medium of the dielectric and excites similar simple vibrations in the secondary conductor.

On the explanation of resonance, the manner of *actio in distans*, its affection by conductors and dielectrics, and the connected formation of maxima and minima of action, we pronounce for the present no opinion, as we hope to find explanations of these subjects by further experiments.

Wine Cellars Lit by Electricity.—Messrs. Moet and Chandon's wine cellars at Epernay, which are the driest and largest in the world, are lighted by the electric light. These cellars are cut out of the solid chalk under a hill, and were visited by President Carnot on the conclusion of the army manœuvres in the Champagne district.

ELECTRIC RAILWAYS FOR RAPID INTER-URBAN COMMUNICATION.

BY CARL ZIPERNOWSKY.*

(*Concluded from page* 354.)

THE best guarantee against derailment is afforded by the superstructure which we have selected. It consists of Vignoles rails 180 mm. in height, and weighing 50 kilos. per metre run, which are screwed on the cast steel sleepers by means of cast steel frogs on each side. The sleepers have planed supports for the rails. They are laid at 1 metre distance, and screwed down upon a foundation of concrete. The rails are supported on masonry for their entire length, so that in case of the fracture of a rail the broken ends cannot leave their position, and there occurs no occasion for a derailment.

The current rails have the same profile as the former chain rails, and are fixed in porcelain insulators by means of cast iron supports, which are cast in special pieces fitting in the sleepers.

The superstructure must be laid down with minute accuracy, and screwed upon a foundation of concrete. This work, as well as the laying a continuous foundation, makes the railway more costly, but we consider both indispensable to guarantee the necessary safety.

The weight and the stability of the superstructure alone determine the safety of the traffic. It is out of the question to lay the superstructure merely in ballast, such a stratum is far too elastic, and does not bind the superstructure sufficiently. The cases of derailment may chiefly be traced to changes in the bedding of the superstructure, irregular settling, the formation of hollows, &c., which give occasion to most calamities.

For our railway system there is the further necessity of forming a very heavy, massive superstructure, then a sufficiently inert and heavy mass can be opposed to the shock which a heavy carriage at so great velocity exerts upon the several parts of the superstructure, which will only then remain unaltered in its position and its texture. There is no need to be alarmed at the disappearance of all elasticity, as the carriage will run very quietly, because it rolls upon a support which is almost absolutely firm.

A permanence of the superstructure can be obtained only by binding it to a foundation which may either consist of two continuous longitudinal walls sunk in the lower earthwork, or of a grating of masonry; on embankments where the foundation cannot be laid in natural ground it must be stronger than in deep cuttings.

As for the under structure, it need merely be mentioned that no high embankments must be constructed, since they do not settle for several years, and afford no sufficient support for the superstructure.

As for the buildings, the conditions of construction are more favourable than on a steam railway. As the traffic is on the principle of a tramway, we have only to reckon on the load of two carriages meeting, *i.e.*, about 120 tons.

The use of viaducts will be found necessary to a much greater extent than on steam railways. The reason, as already stated, is that we cannot expect from lofty embankments that degree of stability which we consider unquestionably necessary for the sake of the safety of traffic. But even on the score of expense, viaducts must be preferred to embankments. This is manifest on the following grounds:—

Tramway intercourse requires that for all long distances the lines must always be carried out with a double track. The introduction of points for changing is out of the question, since on the one hand there would result a considerable delay in the traffic, which must in any case be avoided, and since, on the other hand, the changing points, however well constructed, would always give occasion to unpleasant accidents. But as we must pass the points at a great speed the dangers would be intensified. Such railways must necessarily be constructed with a double track, a condition to be departed from only in case of short lines, upon which there travels merely a single carriage.

* Read before the International Electrical Congress held at Frankfort-on-the-Main, September 8th, 1891.

The two tracks must be at least 10 metres distant from each other, because when two carriages pass each other there are formed very powerful currents of air, and the shock which two such carriages give each other might prove dangerous at a less distance. The interval of 10 metres between the two tracks would occasion the removal of such a quantity of earth that the cost would be greater than that of two independent viaducts running parallel to each other at an interval of 10 metres.

For the viaducts we propose the use of the most approved construction of cement and iron, on pillars 2·5 metres in breadth and of 12—15 metres span. We have calculated that for the conditions existing on the line from Vienna to Budapest such viaducts, with the rails laid at a height of 6 metres above the natural ground, would not be more expensive than an embankment of equal height, even if to economise material ditches were made corresponding to the natural batter.

The two viaducts cost per metre run 140 florins, including the cost of iron stairs for the watchmen on the line. For greater heights such viaducts are cheaper than embankments.

As a matter of course, the railway must be completely fenced in. Level crossings are totally excluded, and all cross roads must be carried above or below the line. The permanent way must be accessible to officials only. In order to facilitate cleansing, we propose to carry the foundations of the superstructure at 500 mm. above the level of the foundations. By this means any snow which attaches itself will be in part swept away by the violent current of wind which accompanies each carriage.

Great care must be taken with the system of signalling. As it may possibly happen that the line watchman must stop a carriage when the conductor has not noticed the signals, the signals are to be made *active*, *i.e.*, each signal given must simultaneously act upon the conditions of the current in the current rails according to such signal.

On this account we establish the following conditions :—

1. Watchmen's boxes are to be established along the entire line, and for a double track they will not be superfluously close at an interval of 2 kilometres.

2. The current rails must at every watch-box be provided with an insulating interruption, and at these places the current must be carried through a regulating apparatus.

3. This apparatus must indicate automatically, if, in consequence of the accidental shortening of the normal interval between two carriages following each other, the local consumption of current is greater than the normal traffic requires. The automatic apparatus must then be fixed in such a manner that the second of two such carriages, as soon as it passes the watch-box in question, receives less current, and is hence compelled to drive more slowly, until the normal interval is restored.

4. Each watchman must also be able, when necessary, to send signals to the neighbouring stations concerning the speed of travelling.

5. Each such signal given by any watchman must be communicated to the conductor by signal discs.

6. The signal discs must be very long, in order that the colours or lights may catch the eye of the watchman in the form of stripes.

We propose to signal with three stripes, which have the following meaning :—

3 stripes, "stop."
2 stripes, "go on at 50 kilometres.
1 stripe, "100 kilometres speed."
0 stripe "full speed."

7. In addition to the above, there are required signals referring to stations, and a mutual telephonic connection between all the watch boxes.

We have arranged this manifold system of signals in the following manner :—

The blocking of the single carriages is effected by means of a current-measuring apparatus, so arranged that it, for each track separately at a certain maximum point of energy, sets in action a battery which rings a bell, and at the same time reduces the flow of energy to the over-loaded current rail, whereupon the watchman takes the further measures needful. If we realise that the supply to the current rails (whatever system of distribution may be in use) must take place at many points in order that the feeding machines may be approximately equally loaded, whereby the energy required in each carriage always enter the current rails at a number of points, and consequently varies within certain limits. At each point it is easily possible to construct the curve of energy arising at each point of entrance, and to found the system of signalling upon the maximum or otherwise the minimum ordinates. The same takes place with bell signals and with a red light.

The signals which have to be given from one station to another consist only in mentioning the number of stripes which indicate the speed of travelling, and are actuated as follows :—

In each station there are besides the above-mentioned regulating apparatus combined with a current-meter one introduction button, two large and two small batteries, two large and two small bells, and two signal boxes, one for each track. For movement by hand there are also in the watchman's box two small boards, each with three keys leading to the signal discs for the tracks. As soon as one of the two meters indicates that one track is over-loaded, the watchman turns the introduction lever to that side to which he means to send a signal. The lever first touches a button, by which the small battery and the small bell of the neighbouring station are set in action. This small bell calls the attention of the watchman there, when the meter there sounds the signal of an overload. When the lever is turned further it makes contact with a second button. To this is connected a key, by means of which the large battery, the large bell, and the signal box are actuated once, twice, or thrice. The neighbouring watchman hears the large bell strike once, twice, or thrice, and at the same time he sees in the signal box one, two, or three stripes appear, and he fixes the signal discs accordingly, to notify the conductor. If in the meantime the carriage has not been sufficiently retarded by the first current connection, the next following meter is set in action when the watchmen there in his turn signals to a further station, and so on.

Power Required.

The power necessary to propel a carriage of about 60 tons in weight, and of about 5 square metres section, is very considerable, and it is, *a priori*, evident that by far the greatest part of the power is needed for overcoming the resistance of the air. In default of precise data ascertained by practical experiments on the various resistances which have resulted in railway traffic, we have examined seriatim all occurring resistances of the kind, and we give the results of our considerations as far as the purpose of the present work requires.

The atmospheric resistance has been most recently measured by Crosby (see *Electrical World*, 1890, vol. xv.), in order to obtain a basis of calculations for a rapid electric railway between New York and Chicago, and he has found values for the movement of bodies of various shapes in quiescent air, which are considerably smaller than the formulæ for the resistance of air which have been hitherto in general use. As Crosby's experiments have been conducted with great care, we need not scruple to accept his empirical formula for the resistance of the air at the front of the carriage.

$p = 0{\cdot}1441\ v$ (pressure in pounds per square foot v in English miles), and the formula :

$$p_1 = \frac{p\,(1 + \cos \rho)}{2}$$

for the pressure against surface moved obliquely.

On the basis of this we can conclude that the resistance of the air for well-built carriages travelling at a mean speed of 200 kilometres does not exceed 250 H.P.

If we wish to ascend steep gradients (10) with the above mean speed, we shall require for a carriage weighing 60 tons about 450 H.P.

We have still to take into account the resistance of curves, the atmospheric friction of the sides, rolling friction, loss of effect by pendulum motion, which from the want of experiments cannot be exactly calculated, but which in comparison with the above figures are very small, and for which 100 H.P. is an ample estimate.

The maximum demand of power for a carriage is therefore 800 H.P., and in consequence each carriage would have to be fitted with four electro-motors, each at 200 effective H.P. A carriage therefore on a horizontal railway, and in favour-

able weather, will absorb about 260,000 watts; but on ascents as much as 600,000.

The tension of the working current cannot be taken above 1,000 volts, since the slightest irregularity, such, *e.g.*, as the stripping of the insulation from the wires by shaking, &c., might, at such high tensions, involve complications which would easily interfere with the traffic. Bare conductors conveying current in a carriage must always be accessible, without danger to life.

A current of 260—600 ampères per carriage will have to be conveyed, which requires very good conduction.

We may now regard the above study as completed, in as far as technical solution of the problem is concerned.

We have still to speak of the manner in which the electric transport of power is to be combined and carried out. But we prefer to devote a separate study to this subject, in which must be introduced the experiences which we are at present collecting with a motor specially constructed for railway purposes.

MEASUREMENT OF THE LIGHT OF THE ELECTRIC ARC AND OF SOME OTHER LUMINOUS SOURCES.

THE formula, say J. B. Baille and C. Ferz, in *Lumière Electrique*, which gives the total quantity of light received by a surface, s, lighted by a luminous surface, s', placed at a distance, D, sufficiently great, is

$$Q = E \frac{s\,s'}{D^2} \cos\phi \cos\phi'$$

ϕ and ϕ' being the angles made by the luminous and lighted surfaces with a straight line joining their centres.

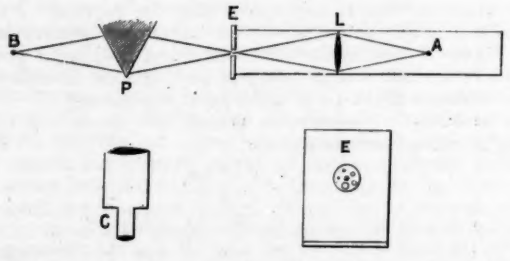
Most photometric methods rest upon the equality of illumination, and the rays from two sources are made to fall at the same angles of incidence.

When equality is obtained between the standard and the source of unknown value, we have

$$\frac{I}{I'} = \frac{D'^2}{D^2} \text{ with } I = \int s\,d\,E.$$

However, if it is the total intensity which is required to be considered, it is indispensable in some applications to determine the factor, E. We will only instance the case of projection apparatus where E should be increased as much as possible to the detriment of s.

In other cases, on the contrary, we should increase s by diminishing the light by means of ground glass globes, as in the case of arc lamps, where the excessive brilliancy of the luminous point fatigues the eye and gives rise, on the other hand, to sharply depressed shadows, and produces an effect the reverse of harmonious.



In order to be able to measure this light from every point of the luminous source, we have employed a very simple optical arrangement, which has given us excellent results; it is the extreme ease of the employment of this method which has induced us to publish it.

An achromatic lens, L, forms an image of the light, being studied on a screen, E, carrying a rotatory diaphragm. The different openings of this diaphragm have surfaces which have been previously measured with great care. The rays passing through this little hole form a perfect cove, giving on the photometer a circular white spot.

The photometer itself is formed by a prism of white polished porcelain, receiving on one side the rays of any light, B, which only require to be constant, and, on the other, the rays which have passed through the diaphragm. A telescope, C, allows the equality of the lighting of the two surfaces to be readily seen.

Let s be the surface of the diaphragm employed for the carcel, and D the distance to which it is from the prism, s' and D' the same factors for an unknown light, then $Q = E \frac{s}{D^2}$ for the carcel, $Q = E' \frac{s'}{D'^2}$ for the other light, from which

$$\frac{E'}{E} = \frac{D'^2\,s}{D^2\,s'},$$

and if we take E (the light of the carcel at the flame) for unity,

$$E' = \frac{D'^2\,s}{D^2\,s'}.$$

This possibility of obtaining equality by varying the two elements, D and s, makes the method a very handy one, the surface, however, of the diaphragm should be sufficiently small, in no case exceeding 2 millimetres; moreover, the employment of the fixed light, B (a complete analogue to the tare of the method of double weighing), eliminates several causes of error and of experimental difficulties which result from the employment of two lenses, one for the standard and the other for the light being measured.

The distance between the screen, E, and the lens being fixed, we must always place the light to be measured in the same place in order to obtain a clear image on the screen.

The light, A, the lens, L, and the screen, E, are placed on the same support; the whole can be approached to, or drawn away, from the prism, P, and the distance, D, figuring in the formula is that measured from E to the edge of the prism.

DETERMINATION OF MAGNETIC AND ELECTRIC CURRENT WORK IN ARMATURES.*

BY HERR HUMMEL.

THE high scientific and practical importance of experimental comparisons between electric and magnetic currents led the firm of Schuckert & Co. some years ago to examine whether it was justifiable in a special case to speak of a magnetic current in the same sense as we have long ago been accustomed to speak of a electric current, and if the laws of both were identical.

The special instance concerned the losses involved in the magnetic and electric work in the armature of a dynamo, and the researches were in the first place directed to the practical purpose of determining the magnitude of each single loss and deciding whether both kinds of work can be calculated according to the same laws.

For the separate determination of the losses there were applied two mutually independent methods.

A.—*Indirect Method.*

Two diagrams are taken of the machine to be tested when running without a load.

I. With a constant number of revolutions and variable magnetisation.

II. With constant magnetisation and a variable number of rotations.

In both cases the machine runs unloaded as a motor.

The magnets are excited separately and so much tension is given to the armature as is necessary to obtain the desired number of rotations.

Ad 1.—In the diagram shown in fig. 1 the tensions at the brushes, Δ, are plotted out as abscissæ, and the corresponding strength of the current, J, in the armature (or the watts taken up by the armature) as ordinates.

To a given tension there corresponds a given strength of current, J, in the armature, and hence, in order to obtain the required number of rotations, an electric work is conveyed to the extent of $W = I\,\Delta$.

This work is essentially composed of three parts:—

1. Work for the mechanical losses;
2. Work for the magnetic losses, and

* Read before the International Congress, September, 1891.

3. Work for the electric losses.

If we call the respective strengths of current i_e, i_m, and i_s, then

$$J\,\Delta = i_e\,\Delta' + i_m + i_s\,\Delta$$

or

$$J = i_e + i_m + i_s.$$

The value for the mechanical work remains constant and follows immediately from the diagram. It is

$$W\,e - W\,o$$

since for $\Delta = v$, the magnetic and electric losses are null.

The product $(i_m + i_s)\,\Delta$ represents the sum of the magnetic and electric losses and results in the diagram from the difference of the ordinates, $W - W\,o$. If we divide it by the tension Δ, we obtain the curve $i_m + i_s$, which appears as a right line of the form $y = C\,\Delta$.

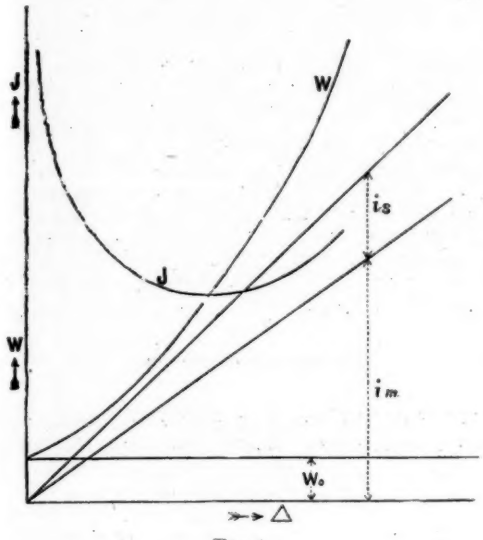


Fig. 1.

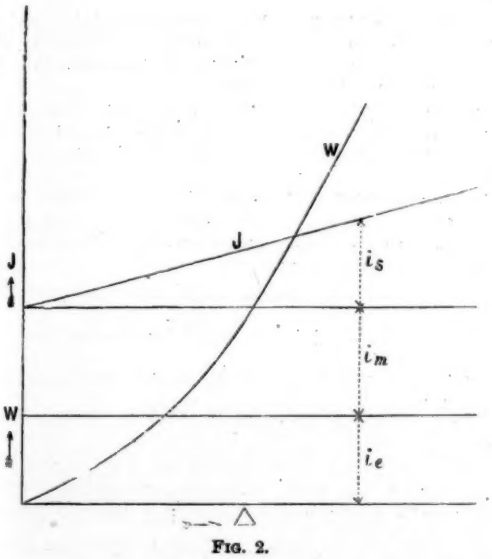


Fig. 2.

As the electric loss of work is known to be proportional to the square of the tension

$$W_s = C\,\Delta^2 - i_s\,\Delta,$$

therefore

$$i_s = C\,\Delta,$$

consequently a right line and the curve i_m must likewise be a right line of the form

$$i_m = C_2\,\Delta,$$

and hence also

$$W_m = C_2\,\Delta^2.$$

The losses in consequence of magnetic work with a variable magnetic current and a constant magnetic resistance follow the same laws as the losses in consequence of electric currents under the same conditions.

Ad 2.—The diagram is shown in fig. 2. I and W have the same meaning, as in the diagram, fig. 1. As the magnetisation remains constant, i_m is also constant, and since, as shown above, i_s is a right line, the curve, I, is a right line when i_e remains constant, as it may be practically assumed in so far as the ventilation work may be neglected.

i_s then agrees in direction with the right line, J. The two diagrams enable us at once to find the separate determination of the magnetic and electric losses of work, since i_e is known from diagram 1, and i_s from diagram 2. Consequently

$$i_m = J - i_e - i_s.$$

It need not be mentioned according to the manner of taking up the diagrams of the machine when running without a load that this method gives the sum of the losses by currents in the armature-circuits and in the copper wires, and that the working losses which arise by short circuiting the commutator segments are not considered. Both cases were specially examined.

B.—*Direct Method.*

a. In machines: The experimental machine is connected by driving bands with a suitable machine running as a motor. At a certain number of rotations the electrical work conveyed to the motor is accurately measured, when the magnets of the experimental machine are not excited. They are then excited and the difference of the energies conveyed into the motor at the same number of rotations gives the measure for the magnetic and electric losses in the experimental machine at a given magnetisation and number of rotations. The yield of the motor must have been accurately ascertained previously.

In the years 1884 and 1885 the firm, Schuckert & Co., made a productive use of this method for determining the effective losses in various forms of iron rings (bands, wires and sheets) and found it completely answer their purpose under the conditions then prevailing. It presupposes, however, very good appliances and makes heavy demands on the skill and still more on the patience of the experimentalist.

During the last year a method has been applied which allows of the elimination of the mechanical losses of work, and enables us to obtain directly the magnetic and electric losses.

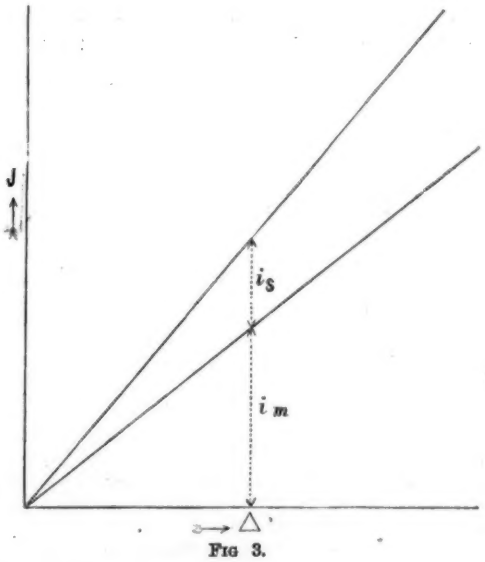


Fig 3.

For this purpose the experimental machine is also connected by driving bands with a motor which when the magnets are not excited gives off to it as much work as the mechanical losses of work at the present speed require. If the magnets are excited so much electrical work is conveyed to the armature of the experimental machine as the surplus outlay of work occasioned by the magnetisation and the elec-

tric currents in the armature, whilst the electrical work conveyed to the motor is kept exactly constant.

If the tensions are plotted out as abscissæ and the strengths of current introduced into the experimental machine as ordinates, we obtain two diagrams analogous to the former, as represented in figs. 3 and 4.

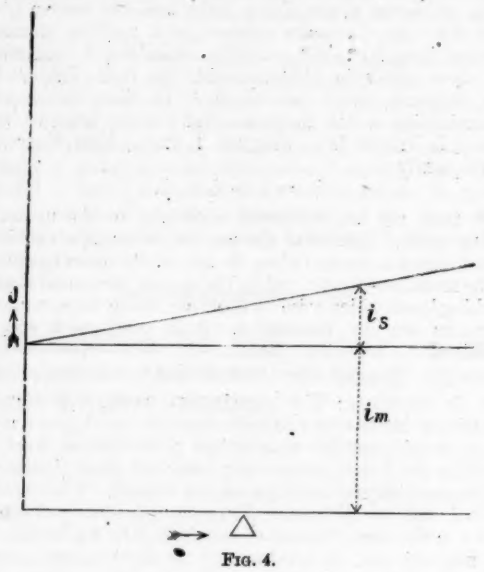


FIG. 4.

The proportion of the strength of current $\frac{i_s}{i_m}$ for every tension gives the proportion of the electrical to the magnetic losses, and the products, $i_s \Delta$ and $i_m \Delta$, give directly both losses.

This method surpasses those above described in accuracy, as it is approximately independent of the changes in the mechanical losses of work.

B.—*In Transformers.*

In order to determine the magnetic and electric losses in transformers a diagram is drawn up, a constant magnetisation and a varying number of changes of the poles, whilst the secondary circuit is open.

The tensions are plotted out as abscissæ, and the watts measured directly as ordinates. Fig. 5 shows the measured

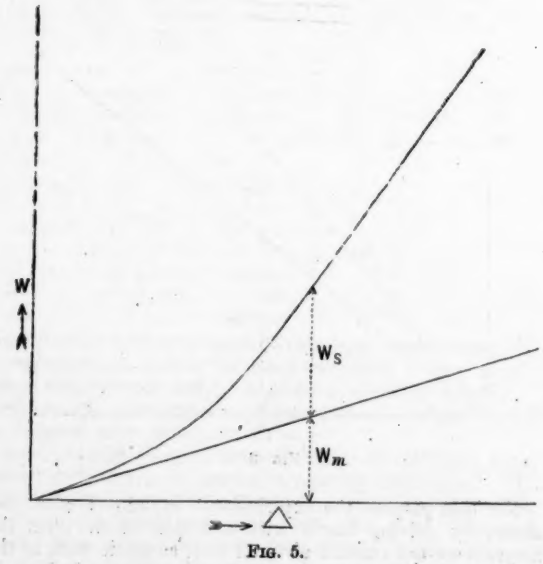


FIG. 5.

watts, deducting the value, i^2 w, of the thermic work.

As the work of magnetisation is proportional to the number of polar changes or to the tension, it is represented by a right line which touches the watt curve at the null point.

If we calculate this tangent from the equation of the watt curve, its ordinates show the values of the work of magnetisation, w_m, and the ordinates of the watt curve, and of this tangent, show the electrical losses.

THE RESOLUTIONS PASSED BY THE INTERNATIONAL CONGRESS OF ELECTRICIANS AT FRANKFORT-ON-THE-MAIN.

IN proportion as congresses of specialists become more and more frequent, they seem more and more to lose sight of the object with which they are instituted. This object is mainly, to arrive at a general understanding with regard to new and little known questions; to establish a fixed scientific terminology; to define exactly the new terms, new quantities and new units, the employment of which is necessitated by the progress of science and industry, and finally to sanction by vote decisions which, by their international character, have the force of laws, and may generally be universally accepted, since these decisions are only arrived at after mature deliberation by competent committees.

Since 1881, international congresses have strayed more and more from this path. With the exception of a few decisions which we are about to give, the general meetings and sectional meetings of the International Congress of Frankfort have been almost entirely occupied by questions which, although certainly very interesting in themselves, would have gained by being treated at the national electro-technical meetings held by the scientific societies of the countries to which the writers of the papers belong. In fact, some of these questions had shortly before been actually brought before these scientific societies and had thus been deprived of all novelty or interest. As it is not our desire to make personal criticisms, but rather to protest against a tendency which seems to us to be opposed to the very institution of congresses, and to the object which they propose to attain, we will mention no names, but merely confine ourselves to calling the attention of those interested in the organisation of future congresses to a state of affairs which we consider deplorable.

The papers which have been distinguished by decisions and votes passed at the general sitting are few in number. Some arose from the general sitting, and were suggested by M. Hospitalier's paper on "Electro-technical notation, conventional terms and symbols," the others which were also put to the vote at the general sitting, were formulated by the fifth section. We will now give the decisions arrived at.

I.—*Notation, conventional terms and symbols.*

The following decisions were unanimously agreed upon at the general sitting of September 12th, 1891.

(*a*) The Congress decides:

1. That symbols of physical magnitudes shall be expressed by italics. (M. Hospitalier's proposal.)
2. That units shall be expressed by Roman characters. (M. Hospitalier's proposal.)
3. That physical constants and angles shall be expressed by Greek letters. (Mr. Preece's proposal.)

(*b*) The Congress decides:

That while it recognises the following designations: *Watt* for the volt-ampère, and *Joule* for the volt-ampère second, names decided upon by the International Congress of Electricians, held at Paris in 1889, the practical electrical units shall be represented by the Roman capitals commencing their respective names, viz.:*

Ampère, A.	Ohm, O.
Coulomb, C.	Volt, V.
Farad, F.	Watt, W.
Joule, J.	

(*c*) M. Hospitalier, having established a system of notation which would, in his opinion, be capable of designating all the important physical quantities without introducing any

* The recognition of the Watt and the Joule was suggested by M. Hospitalier. The employment of the Roman capitals as abbreviations of the electrical units was proposed by M. Roiti.

appreciable modifications into existing arrangements, we recommend the members of the committee appointed by the Congress* to examine this system which is advocated by the committee in a general way, and to submit it to practical tests; to publish shortly in the special technical journals the results of their examination with a view to a common understanding, and to leave it to the next Congress to establish definitely this system of notation.

II.—*Proposals of the Fifth Section.*

The following proposals were carried unanimously at the general sitting of September 12th.

The International Congress of Electricians of 1891, at Frankfort, declares:—

1. All preparations to establish or manage electrical installations, should be made with regard to the principle that every such installation should be protected against being influenced by other installations. This does not necessitate a separation between weak current installations and strong current installations.

2. The opposing influence of an electric lead cannot practically be wholly avoided. It must therefore be considered sufficient if we so lessen these influences that they do not hinder effectual working.

3. The present state of electrotechnics enables us so to arrange electrical installations as to protect them sufficiently against disturbing inductive action.

4. The employment of the earth as a return conductor or the connection to earth of a conductor cannot up to the present be wholly dispensed with in electrical installations.

We must therefore employ the earth in such a manner as not to exclude single installations or sets of installations.

5. The interests of public safety and order with regard to electrical installations and services, and also the regulation of their connection with one another and with other public works, should be taken into consideration by the authorities who are not personally concerned in such services.

It is desirable, therefore, that municipal councils should include among their members competent technical men.

Otherwise, electrical installations and services do not require special consideration.

NEW INSULATING MATERIALS FOR GENERAL ELECTRICAL PURPOSES.

An improved insulating medium for electrical purposes in general consists of a mixture of sulphur, pipeclay, slate dust, wax, and some metallic oxide, the latter being added on account of its cohesive action whereby it assists the wax in binding the other ingredients together, and also on account of its colouring properties.

The proportions in which these ingredients are used are as follows:—

Sulphur	7 lbs.
Pipeclay	1½ „
Slate dust	1½ „
Paraffin wax	2 oz.
Oxide	variable.

The quantity of oxide added chiefly depends upon the colour which it is desired to give to the mixture; it may vary from one-half to one-fourth of the total weight of the other ingredients.

In working up this mixture the clay and the slate dust are first thoroughly mixed together by grinding, the materials being heated. The paraffin wax is then added and the mixture incorporated into a paste.

After exposure for some time, during which it becomes dry and hard, the mixture is ground to a powder and then mixed with the proper quantities of sulphur and metallic oxide. There is, apparently, no information available respecting the relative power of insulating possessed by this new medium.

* The committee appointed at the sitting of September 10th, was composed of M. Ferraris, the President, Messrs. Ayrton, E. Gerard, Hospitalier, Kohlrausch, Löwenherz, Nichols, Preece, Quincke, Roiti, Strecker, Silvanus Thompson, Uppenborn, Weber, Wülner, members, Carl Hering, secretary.

Another invention has for its object the economy of gutta percha, and similar expensive materials, in the manufacture of insulating compositions for electrical purposes.

Wood fibre, hemp, flax, jute, cotton, silk, woollen, or other suitable materials, are saturated with some drying oil, *e.g.*, linseed oil, which has been previously heated up to a temperature of 350° Fah. with litharge or some other oxidising agent.

The fibre thus treated is then dried and again saturated with oil, the process being repeated again and again until the fibre has increased in weight by at least 50 to 100 per cent.

The dry fibre is now worked up into a homogeneous mass by the action of rollers running at a high speed, and then about 25 per cent. of gutta-percha or India-rubber is added, and so amalgamated with the fibre that the latter can afterwards be formed into blocks or rolled out into sheets, &c.

It is obvious that this process *does* effect a considerable saving of gutta-percha, the only question is, how does it compare with rubber for the various electrical purposes in which it is used?

In another new insulating medium the chief features are as follows:—Very finely powdered quartz is dried and made into a plastic mass with a solution of crude potassium or sodium silicate, colouring substances being added for appearance sake. The mass is moulded to any required shape, and may have pieces of metal imbedded in it for lamp-holders. It is then slowly dried and finally brought to a red heat. A glazing mixture gives a finish to the surface. This composition is stated to be very useful for insulation between commutator segments, for lamp fittings, &c.

PRACTICAL PHOTOMETRIC RESEARCH.

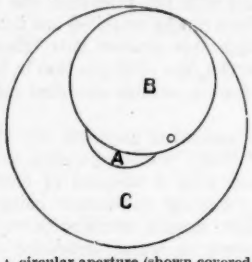
By RALPH CONRAD RICHARDS.

(*Continued from page* 357.)

Light Standards.

It will now be necessary to deal with light standards. Much has been written concerning a practical standard of comparison, and it must be regarded as peculiar that, despite the numerous researches which have been conducted in this direction, little advance has been effected. There are many properties which incandescent bodies offer, which render them available as standards for rough purposes, although it becomes difficult to design a really constant equivalent of the standard candle. It is, however, a strange condition of things that people search so eagerly for constancy in this direction, when the final test is carried out under circumstances which render it impossible to determine the ratio between the lamp whose light ratio is to be determined against the standard, with accuracy. The *standard* candle, it is proper to remark, is far less constant in its light-giving qualities than the many devices against which it is compared, for the purpose of arriving at a constant secondary standard. Thus it happens that these secondary standards are by far preferable in every respect to the so-called standard candle; the very looseness of the official requirements serve to show this; the gas referees rejecting only such candles whose consumption of combustible material falls without the wide limits "not less than 114 nor greater than 126 grains per hour." Under these circumstances the regulation burner furnished with a Methven screen would seem far preferable, for experience shows that this latter is one of the most constant things of the kind capable of reproduction. Concerning the candles themselves, it may be truly remarked "their name is legion," and it appears marvellous that so much attention should have been devoted to their production when experiment has proved the great disparity which manifests itself between them. After all it does not depend so much upon the amount of organic substance consumed as on the actual conditions affecting this combustion; thus the regularity of the wick is very important, and the temperature at which the test is made renders it the more so. Stearine at 50° Fahr. is a hard compact material, whilst at 70° it is far softer, and therefore more readily susceptible of volatilisation, and to render this

lack of uniformity more conspicuous, it must be remembered that a chemical process, such as combustion, takes place with far greater ease at a high than at a low temperature, and is consequently less perfect in the latter case than in the former; to this fact is to be attributed in no small degree the advantages of the regenerative principle, as applied to gas and other burners, for the enhancement of their luminous properties. This fact is still further attested to by the following experiment, which is within the easy reach of all:—Place a disc of asbestos millboard over an ordinary gas globe, and let the former be provided with a perforation or circular aperture of about 2 inches diameter (this being furnished with an adjustable cover of mica or asbestos), thereby rendering it possible to close the aperture to any desired extent, as in fig. 6. It will now be seen on igniting the gas, and replacing the



C, asbestos cover; A, circular aperture (shown covered over in diagram); B, mica or asbestos adjustable disc.

FIG. 6.

cover, what a very great enhancement of luminosity the burner undergoes when the millboard cover is adjusted sufficiently. Now, this is not exactly due to the regenerative principle, for the products of combustion escape much the same as they did before applying the apparatus; hence it will be seen that the main reason whereby it is possible to account for the elevation of luminosity is due to the elevation of temperature, and deductions are easily capable of being made in regard to the case of standard candles burning at different temperatures. Below is given a list of the different standards which various experimenters have proposed from time to time (due to Marx).

TABLE VI.

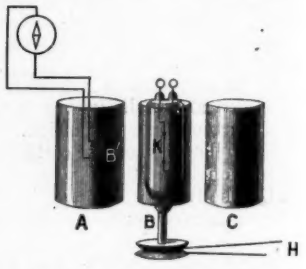
Standard.	Grains per hour consumed.	Light in standard candles.
Stuttgart standard wax, 4 to 1 lb.	119·6	1
Stearine, 5 to 1 lb.	153·7	1
„ 4 „	146·7	0·9
Paraffin, 8 „	111·1	1·1
American sperm oil (sp. gr. ·808)	233·1	3·2
Photogen oil (·810)	220·7	3·0
Shale oil (·817)	223·8	3·0
Rape oil (usual purified)... ...	307·4	2·8
Coal gas (at 21 mm. pressure) ...	4·5 cub. ft.	6·0
„ (at 8 mm. pressure) ...	...	10
Paraffin oil, sp. gr. doubtful (writer)	700	7
Kerosine (writer)	475	3½

In addition to the above, there are several standards which still remain; these are—

1. The Carcel lamp consuming 42 grammes of pure colza oil per hour, and yielding a light of 9·6 candles.
2. The "Verein" paraffin candle, whose flame is 50 mm. in height, and weight 83·33 grammes.
3. The Munich stearine candle, burning 160 grammes per hour.

Amongst other standards which have been proposed, but which are not in general use, is Bunsen and Roscoe's standard, which depends upon the combustion of air in carbonic oxide, the air being consumed at the rate of 5 cubic centimetres per second. There is also the Violle and the Siemens-Violle lamp, depending upon the light yielded by a piece of platinum of determinate size at its melting point. Perhaps one of the most reliable standards obtainable is a lamp burning pentane, which yields a uniform and very white flame; the reason of the uniformity is in all probability owing to the fact that pentane being a definite compound (obtained by rectification from petroleum), is not subject to those alterations to which other organic bodies of unstable composition are susceptible. When an ordinary standard, such, for instance, as is suited to ordinary installation work is required, perhaps a gas flame of the Argand type will be found to satisfy all requirements, if used in conjunction with the Methven screen, care being taken that the aperture is always placed in the same manner, relatively to the flame, and that the tint of the light (viewed through the aperture) is fairly uniform. For a standard of comparison, the device due to Schwendler may be employed; this consists of a horseshoe shaped piece of platinum foil, through which a current of determinate strength is passed. The author thinks that this might be rendered perfectly reliable, provided that a greater efficiency than 4½ watts per candle were not expected—the idea of this limitation being, that if this be exceeded, a liability to burn more brightly, which is perhaps due to disintegration, is encountered. Perhaps a very accurate standard could be secured by taking a piece of thin platinum wire of uniform section and length, and stretching it between two supports, which could serve the purpose of terminals; the whole could now be sealed into a globe hermetically, thus forming a modified glow lamp, as in fig. 7. This being caused to rotate between two vessels at about two revolutions per second, as in fig. 8, it is plain

FIG. 7.



A, jar filled with ether, into which the thermopile, B¹, is immersed; B, jar (containing lamp driven by pulley, H; C, jar containing sensitive salt of silver with organic substance in solution.

FIG. 8.

that each vessel would receive an equal amount of radiation in a given time. If, now, one vessel be used as a calorimeter, whilst the other be filled with some solution sensitive to light, means are at hand whereby it is possible to measure both the total heat radiation, and also the chemical action due to, say (in the case of a silver salt, with an organic substance present, in solution), the ultra violet radiation. Let the standard be the amount of radiation sufficient to yield results affording a ratio of determined value in a certain time, and it will always be possible to reproduce this again when required by means of an adjustable resistance in the lamp circuit.

This method would have the following advantages:—

1. Independence of external temperature,
2. Constancy, and
3. Readiness of reproduction.

It should be remarked that the test should always occupy the same time, which might be perhaps five minutes or so.

The platinum thread, K, would of course be the centre of rotation to avoid the possible introduction of error due to vibration.*

In carrying out this test, it would be necessary merely to observe the indications of a galvanometer, connected up in circuit with a thermopile immersed in some ether contained in the jar, A, and also the amount of organic substance rendered insoluble by the decomposition of the silver salt in the jar, C. It will be obvious that as this ratio would differ with every difference in the time during which the experiments were conducted, it should for this reason be limited to a standard period. If the sensibility of the silver salt for light equalled the sensibility of the thermopile for heat, then, as it would be possible to make computations, a standard period would be unnecessary; but even in this case very undesirable complications would be introduced; in any case, however, a standard period is far preferable, in order to avoid complications and inaccuracies which otherwise might easily occur. This method is, in the writer's opinion, the nearest approach to an absolute standard which has, as yet, been devised. Regarding rough standards, it has been found by several experimenters that the ordinary sperm candle differs less from the standard than do the standard candles from one another. *(To be continued.)*

* The lamp is shown in fig. 8 enclosed in the glass vessel, B; this is to prevent any cooling effect on rotation.

A CENTRAL STATION COMBINING THE ADVANTAGES OF BOTH THE CONTINUOUS AND ALTERNATING CURRENT SYSTEMS.*

BY H. WARD LEONARD.

WE are all well aware of the fact that the greatest strength of the three-wire system is due to features the lack of which constitutes the greatest weakness of the alternating system, and that the reverse of this statement is equally as true.

The high efficiency, reliability, safety and adaptability to supply almost any requirements for electric energy, which are the features of strength of the three-wire system, are the very points upon which the alternating system suffers by comparison, for its efficiency is much lower, its reliability is less, due to the fact that its machines are not practically operated in multiple arc, its safety is necessarily less, due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro-deposition, and so forth.

On the other hand, the low first cost of an alternating system, the simplicity of its circuits and of the operation of the central station, and its ability to reach, with moderate expenditure of capital, lighting at any practical distance, make it the only possible pioneer in new and untried territory without great risk and almost the certainty of expending capital which will never be remunerative.

Hence it is that we find the three-wire system in possession of the densely settled centres of cities and towns, and not extending to the outskirts because of the uncertainty of a sufficient return upon the necessary capital, and both the central station manager and the distant would-be consumers anxiously awaiting the development of improvements which will enable the three-wire central station to supply such distant consumers. And hence it is that the manager and consumers of an alternating system anxiously await the day when motors can be operated, and a more economical, safe and reliable current than the present alternating current can be furnished by such a station to supply the imperative wants of the heart of a busy city.

If the above statement of the present existing conditions be a fair one, it will be evident that if we could only in some way secure the advantages of both systems in a common distribution, we should greatly improve matters. The object of this paper is to point out what appears to the writer to be a step forward in that direction.

The following conditions seem to be necessary:—

1. We must supply a continuous current for the central portion of a town during the daytime when power is required.
2. We must supply the outlying districts with an alternating current during the night time, when lighting is required.
3. We must not operate the alternating system under conditions of light load when its efficiency is very low.
4. We must be able to supply current for lighting continuously throughout the 24 hours of the day.
5. We must have but one set of conductors in any consumer's place.

In order to meet the above conditions, I propose the following:—

1. Wire all consumers upon the standard three-wire system.
2. Connect all consumers upon standard three-wire main.
3. Arrange the network of mains so that the central section of the network can be disconnected from the outlying sections through the agency of switches.
4. Instal three-wire feeders to supply the central portion of the systems at full loads, and instal 1,000-volt primary wires and alternating current converters with a three-wire secondary circuit to supply the outlying section at full load.

Let us see how we will operate the station. Suppose it is 8 o'clock in the evening. The switches which serve to connect the central and outlying sections are open, and our three-wire plant is supplying the full load of the central portion of the city. The alternating plant in the same central station is supplying the converters of the outlying section, which converts from 1,000 volts primary to 220 volts in the secondary, and the secondary coil has a connection at the centre which is led off to supply the central wire of the three-wire system of the outlying section, the outside terminals of the secondary being connected to the outside wires of the three-wire system. It will be noticed that both plants are being operated at full load.

Now, suppose it to be 11 o'clock. The load has gone off rapidly, so that the alternating plant is now operating under the worst possible conditions, and these conditions will continue for the outlying district until dusk the next day—that is, for probably 18 hours. An operator is now sent out who goes to each section supplied by a converter, and, by throwing a switch, transfers the secondary wiring from the alternating system to the three-wire mains. In this way the small remaining load is gradually transferred to the three-wire plant, and then the alternating plant is shut down. The three-wire plant continues in operation all night and all the next day, supplying all devices with a continuous current. Motors can be operated in all portions of the system, even for domestic purposes in the distant residences, and all consumers get the opportunity of the use of the continuous current for any purpose desired for 18 hours out of the 24.

Dusk now arrives, and soon the heavy lighting load will rapidly come on, and in such case the outlying section could not be supplied by the small wires feeding the distant three-wire section during the day, which are only about one-tenth the size which would be necessary to supply the full load.

The operator again goes round the circuit and now transfers the load of the outlying section from the three-wire plant to the alternating plant, and this condition prevails again until 11 o'clock arrives, when the operation is repeated, as before described.

The switches for transferring the load of the outlying section from one system to the other can readily be controlled by simple means from the central station itself, if desired.

Now let us look at some of the advantages we have gained:—

All of our inside wiring is done on the three-wire system for use of a lamp of 110 volts. This means that for the same distances and loss in conductors we will save eleven-twelfths of the cost of copper which would be required by a secondary using 55-volt lamps upon a two-wire system, or, put it another way, we can supply 110-volt lamps upon a three-wire system with the same cost of copper and the same percentage of loss in conductors at three and a-half times the distance which would be permissible for 55-volt lamps on a two-wire circuit.

We all know the great desirability of using large converters, on account of their cheaper first cost per lamp and their higher efficiency, and also because a far more perfect regulation of pressure can be obtained upon a lot of lamps scattered in different kinds of stores throughout a block, if they be supplied from one converter, than can ever be obtained by supplying these lamps by a lot of small converters loaded differently in almost every case, and consequently supplying a different pressure at the secondary terminals of each converter.

Under the system proposed by me one converter would ordinarily supply the entire lighting of a block, resulting in less first cost, higher efficiency of conversion, longer life of lamps, greater reliability and greater simplicity of plant.

A point worthy of notice is that for 18 hours out of the 24 an absolutely safe pressure is in use throughout the entire system, and that during all daylight hours when the greatest liability to accident from contact with high pressure wires exists, no high pressure is in use.

With such a system no consumer need be turned away.

The consumer who wants to charge storage batteries, and also make electric welds by electricity, can do so upon the same day and from the same wires that supply his incandescent lamps.

The factory upon the outskirts of town, which runs its isolated plant, and must to-day either use storage batteries or run machinery all night to supply a few watchmen's lights, can now switch on to the central station at six o'clock, and operate the few lamps it may need until dusk next day, when heretofore the alternating system, which was the only one which could reach it, did not run after midnight, or possibly after daybreak, because of the loss of money in so doing.

With this system the outlying districts can be pioneered with the least first cost and least risk. Any outlying section in which, for any cause, the demand increases greatly beyond that originally anticipated, can be supplied permanently by the three-wire system by merely running the necessary feeders to supply the already existing mains, and in such case the switches and converters would be moved out further or transferred to some new section ready for pioneer work.

The combination of a storage battery system and an alternating system also presents peculiar advantages. The storage battery is at its best when supplying a small steady load, such as we have for at least 16 hours out of the 24. The alternating is at its best when supplying the full load possible only during the remaining eight hours. The average electrical load on a general system is only about 12 per cent. of the maximum, consequently we are entirely safe in the statement that the greatest load during the 16 hours of light load is not more than 10 per cent. of the maximum load for the 24 hours.

If we were to attempt to operate the heavy load by storage batteries, we must either make an enormous investment, or, what is even worse, operate storage batteries at a disastrous overload. On the other hand, if we try to operate the 16 hours light load with converters, our efficiency, when operating at 10 per cent. of our converter capacity, would be unmentionably low. But reverse the case and everything works at its maximum efficiency. During the eight hours of possible heavy load, we operate all devices by the alternating system. At the same time a continuous current dynamo charges our storage batteries located either in the central station, or, if more desirable, at different centres in the system of distribution. At the end of the eight hours' run we shut down the plant, lock up the station, and leave it for 16 hours, the storage batteries meantime supplying all devices.

If, for extraordinary reasons, we have not capacity sufficient in the storage batteries to supply the demand, we run the continuous current plant to assist it; and if that should fail or prove insufficient, we start up our alternating and supply all or a disconnected part of the system with it.

With this plant distances are of no consequence; we can use 1,000 volts for the continuous current plant as well as for the alternating, and the single two-wire distribution is all that is necessary for perfect results.

The weak spots of this latter arrangement will, no doubt, be thought to be the storage battery, but my experience with this device is that if you use it properly under suitable conditions, and do not attempt to squeeze impossible results out of it, economical and satisfactory service can be obtained from it, and certainly no better conditions could be obtained for it than those described above.

Up to this time a bitter fight has waged between those believing that the alternating, the direct, or the storage battery system respectively, was the only suitable one.

I believe in them all, each operated so as to be used under the best conditions for its use, and I trust that the suggestions given above may lead to our being better able to meet and overcome our common enemies—high first cost, low efficiency, danger, unreliability, and the inflexible conditions of the existing demand.

Mr. T. CARPENTER SMITH: I am afraid that in rising to speak upon

* Paper read before the fourteenth Convention of the National Electric Light Association, Montreal, September, 1891.

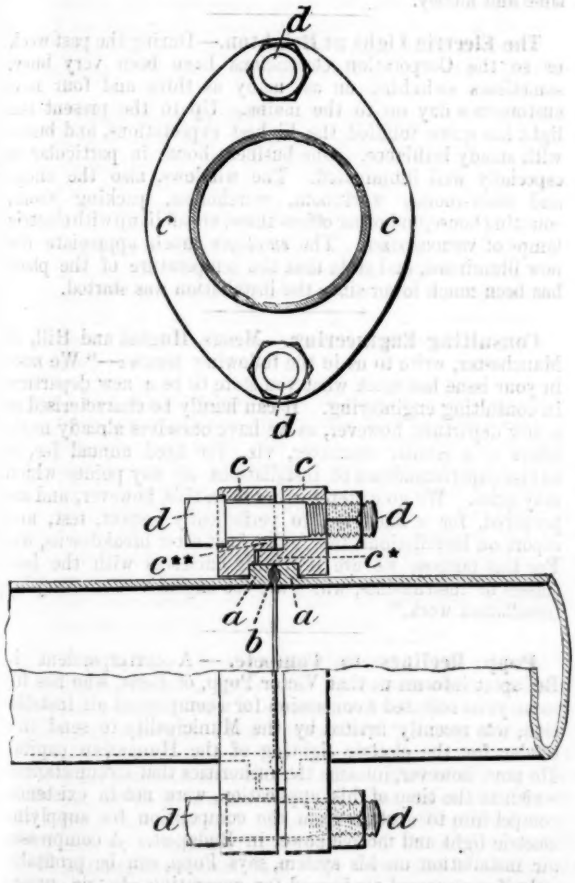
this paper, my audience will understand pretty well what ground I am going to take. I wish to begin by remarking that history has told us, and has repeated its story over and over again, that no state, no municipality, no corporation, nor any individual can afford to defy public opinion. It may seem to do so successfully for awhile, but it must ultimately be crushed by public opinion, which, if it be leaden footed, is also iron handed. I think if there is one feature in our business which has been overlooked, it is the relation with which we are most concerned, and that is the relation which it bears to the public. We have been accustomed to speak of the efficiency, the reliability, the safety, the easy adaptability of any of the various systems in use, only with reference to the relation that those features bear to the central station itself. The consequence has been that all currents using high tension have almost, without exception, in the first years of the business, been installed in such a manner as to be a serious menace to life and property, and therefore have been universally condemned by the uninitiated public. I wish, therefore, to say that whatever remarks I may make are based upon the relation of electric lighting to the public, and not its relation to the central station. With that statement as a starting point, I wish to join issue at once with Mr. Leonard in his statement that the alternating system suffers by comparison with the three-wire system, "for its efficiency is much lower, its reliability is less, due to the fact that its machines are not practically operated in multiple arc; its safety is necessarily less, due to the existence of the high primary pressure, and its current is not adaptable to commercial use for motors, charging storage batteries, electro-deposition, and so forth." I will start out at once with the first of these—as to its efficiency being much lower—and will say that the efficiency, from the standpoint of electrical engineering, the average efficiency during the 24 hours load, the converter system, as at present installed, may be lower than that of the three-wire system. But with regard to the satisfaction of the public, I think that the efficiency of the alternating system is considerably higher. I have been operating now for nearly four years an alternating system, and we supply 3,000 lights in a district of the area of six city squares. We cannot go any further because we cannot get a franchise. Our district is honeycombed by the three-wire system. Their central station is within a block of us. Their wires run down every block on which ours are found, and on some blocks where ours are not. They have connections in nearly every building in that district, and yet they have never succeeded in taking a single light from us. On the contrary, we have taken several customers from them, simply on the ground that their customers could not stand the poor regulation. The sudden changes in the light annoyed customers so much that they preferred to come to us. We have never lost a customer from bad service. We have thrown several off, but we have never lost one. Mr. Leonard says that "its reliability is less, due to the fact that its machines are not practically operated in multiple arc." I do not think that that amounts to anything, and for this reason, that while their machines are not generally operated in multiple arc, still they can be, and if there were any necessity for it they would be so operated. I do not think there is any necessity for it, and I prefer not to do it, because I think that in case of accident to any one machine there is far less danger of accident to others. Any one machine being broken down does not give you the risk of breaking down other machines running on the same circuit. The time required to throw in the switch of a relay machine is not more than the time which is required to throw in the switches which Mr. Leonard uses for transferring from one system to the other. In actual practice that simply amounts to the winking of the lights for one instant. Another advantage, and one in which safety is also concerned, lies in the fact that the alternating system has its load divided up into small units. That is to say, no matter how badly the wiring may have been done in any one building it does not affect any other building, and one customer cannot threaten the safety of every other customer of that station by having his apparatus or the wiring in bad condition. The failure of one group does not affect any of the others. The alternating current in itself, from the mere fact of its being an alternating current, has an immense added safety in the fact that it will not strike an arc. It is difficult to follow an arc with it except under very high pressure. We have had that illustrated over and over again in lamps under conditions where a 50-volt direct current would cause the blowing of the fuse. A very serious question which was brought before the committee on safe wiring is one that we have got to face before very long, and to consider seriously, and that is the grounding of the neutral wire. There have been several arguments brought forward why this should be allowed. It practically came down to this, that the insurance agents and inspectors have preferred to ground the neutral wire, and practically make a return to the one-wire system of installing electric lights, to avoid the much greater danger of the 220-volt arc between outside wires, and the consequent damage in buildings where combination fixtures are used. Now I do not know whether it is not a good thing to go back to the one-wire system of wiring. That is an engineering question that we shall have to determine by years of experience. But I do know that if the grounding of the neutral wire is permitted, you must also permit the grounding of the transformer. You cannot make fish of one and flesh of the other. And more than that, I do not believe that is the real reason of the desire for the grounding of the neutral wire, but that it is rather due to the fact that any failure of the third wire would cause the blowing out of the lamps one side, or the other, according as the load may be placed. That objection would equally apply to Mr. Leonard's plan of wiring up all lights on the three-wire system. I think that the inherent defects of the three-wire system are enough to forbid its use. The two-wire system will meet these conditions. You can do your wiring on that system, if you please, on 100 volts—although I think myself that the lower voltage we get and the larger the conductors we get, the better safety we get—and the slightly additional cost in installation is generally borne by the consumer. The statement that with large converters we get cheaper first cost, higher efficiency and better regulation of pressure, I fully agree with. I will speak of that later on, when I come to point out the method of alternate distribution, which I think meets all the points that Mr. Leonard desires. The statement that the safety of the alternating current is necessarily less, due to the existence of the high primary pressure, I beg to deny. The three-wire system in use gives an absolutely continuous metallic contact from dynamo to lamp, from street main to lamp, and from every lamp on a circuit to every other lamp on that circuit. These three-wire systems, finding that they could not operate their street circuits with any economy, have installed high tension machines, carrying considerably higher voltage in many cases than the ordinary alternating system. It is very evident that the first contact between that high pressure wire and the street main at any point, however slight it may be, puts that high tension on every lamp on that circuit. To do that with the alternating system you have to break down the insulation of every converter. Personally I have never known of a case of contact between the primary and secondary coils of a converter. I know that such have occurred, but I do not think that there has ever been one worth considering when we think of the enormous number of converters that have been put into service, the immense strides that have been made by the alternating system, and the small knowledge we had of it when we first started to instal it. These are accidents which will teach us lessons, but which should not lead us to a condemnation of the new system. The high primary pressure we must have, no matter whether we use the continuous or the alternating current. We cannot carry the current without it. It is exactly the same as with water pressure, or with steam pressure. Twenty years ago 50 lbs. was considered high steam pressure. To-day 80 lbs. is the average. I do not think that of the new boilers that are being installed, less than 25 per cent. are being put in for a pressure of less than 150 lbs., and in 10 years 150 lbs. of steam pressure will be used where 80 is now used, and 200 lbs. where 150 is now used. We know that in all new stations that are being installed, in all new plants where steam is being used for power, the constant tendency is to raise the pressure. It is kept safe simply by the addition of proper precautions, due to the increased pressure. The statement as to its current not being adaptable to commercial use for motors, so far would seem to be proved; but four years ago that same argument was brought forward—that the currents could never be used for meters. I think that the alternating current meter has pretty well fought out its own case, and worked out its own salvation. I do not think that to-day there is any direct current meter on lines in which they are in use, which can compare with the meters which have been brought forward as the direct result of the introduction of the alternating system. I therefore think that in a few years we shall see the motor in the same way. We do have a demand, however, for power, and so far we must admit it that the alternating motor, except in small sizes, is not well adapted for use for certain central stations, although it is of great use in isolated installations. I think, however, the experience of every central station is that it is better to have separate circuits for power and for light. And I think that this plan will meet fully all the requirements of the central station, and that you can use the alternating current for your lighting, and the continuous high tension constant potential circuit for your motors. That constant potential circuit can also be used for charging storage batteries, and for any of the other purposes for which the direct current is used. The safety to the consumer by the use of converters is not only limited to the accidents from the motor itself, but it also has its value in the case of light installations. Not long ago there was a discussion between the advocates of the direct and of the alternating currents, at which one of the advocates of the direct current called attention to the fact, and gave it as a warning against adopting it, that the converter was simply a good lightning arrester to protect one company at the expense of the other, and one alternating current advocate present had the good sense to rise at once and thank him for the advertisement. I do not think that there is any stronger argument which you could use for its adoption. The people who are operating stations presumably know what they are about. They know that they are handling a dangerous element, and they will take care of it. Their *employés* should be well instructed, and then if an *employé* is injured it must be due either to his own carelessness or to those accidents which must to a certain percentage always happen. I think when you sum up the disadvantages of the alternating system you will bring them practically down to one, and that is poor efficiency on low loads. To meet that a system must be devised which will have all the advantages of the alternating system, and which will have an efficiency practically the same at high load as at low load. At high load I think that the efficiency of the transformer system is as nearly perfect as we are likely to get it. The further improvements will come in by the use of better material and of greater care in manufacturing. With these improvements I think it will pretty nearly reach the theoretical advantages. The 1,000-volt primary current which is in ordinary use is not high enough for large cities. Ferranti uses 10,000 volts, and has been operating under that current for several months, and with apparently great success. I think there is no doubt that the time must come when we will use higher pressure than 1,000 volts at central stations, and then get right out in the outskirts where we can have cheap fuel or water-power, and from there send into the city under high pressure the whole current, taking off nothing on the way, that we will have sub-stations where the current will be reduced from very high pressure—which must not be handled at all—to a lower pressure midway between the generating pressure and the distributing pressure, and with that we can supply the districts. In the sub-station it will then be possible to instal three or four large converters, or any number that may be required, connecting them up in multiple arc, and then when the load gets light, instead of changing over to another system we will simply cut out some of those converters on both ends, leaving only fully-loaded converters to carry the load. This, of course,

is open to the objection that it requires the presence of an attendant, but devices have been and are in operation in England whereby that change is made from the central station by means of automatic switches which can throw in one, two, three, four or five of those large sub-converters. I do not believe in the use of small converters. I think the larger you can keep your converters the better, but yet we have to weigh very carefully the disadvantage of having too few lights on one converter and too many lights in one group, where by grounding of one part of the group you may affect the safety of another part. It is between these two limits that we must fix upon our most efficient size of converters. In figuring up the size of blast pipes used in our large rolling mills, and in the size of water mains, that question is continually coming up, and the limits on one side are the interest on the extra money expended in the first place and the loss by friction, or by resistance, or by pressure, or whatever it may be. The use of the two systems in this way, by keeping all the customers continually wired up upon an alternating system, avoids great danger of connection between your high tension wires and your low tension main. If your low tension wires get crossed with your high tension direct wires for the supply of power, the station may be hurt, but the consumer is not likely to be. Say, what you will, it comes down to this—that it is the consumer who will regulate the running of your station. If he does not regulate it by legislation he will do it by hurting your business, by refusing to take what you supply under arbitrary conditions. And so we come back to the proposition with which we started—that no corporation, individual, or Government can say "the public be damned" and not suffer for it.

(*To be continued.*)

AIRD'S "DOUBLY SECURE" TUBE JOINT.

This invention, which is patented in England and the principal foreign countries, has been specially designed by Mr. Joseph Aird for use in connection with his renowned "lap-welded wrought iron and steel tubes," and it is applicable alike for steam, gas, water, hydraulic, compressed air, and other pipes. The joint, which is perfectly unique in its simplicity and efficiency, is constructed as follows :—



The two lengths of tube to be connected are formed with flanges, *a*, thereon, which are grooved to receive a ring of asbestos or other packing, *b*, and upon these tubes are placed two loose clamping collars, *c*, which bear against the flanges, *a*, and by means of bolts and nuts, *d*, are caused to force the ends of the tubes together, compressing the packing, *b*, between them.

Upon one of the loose collars, *c*, is a flange, *c**, which covers the joint and renders the blowing out of the packing, *b*, impossible, and upon the other loose collar, *c*, is a flange, *c***, which overlaps and supports the flange, *c**. From the foregoing explanation it will be seen that this is the simplest and most practical joint in the market, little or no fitting being required in its manufacture, and inasmuch as it requires no screw threads upon the collars or pipes, it can be put together and taken apart quicker than any known joint.

The joint will withstand any pressure up to 5 tons to the square inch, and it is therefore applicable for all purposes, and by reason of the peculiar overlap of the loose collars it is evident that it is in effect what the patentee claims for it, namely, "doubly secure." This simple but important invention has not been long making itself known and appreciated, and the works of the patentee are now busily engaged in the execution of a number of important British and foreign orders.

NOTES.

The River Plate Electricity Company, Limited.—A shareholder of this company recently wrote as follows to the *Financial News* :—"On reference to the last balance sheet of this unfortunate company, it will be found that the total profits (including a small sum received for interest) for the year ending December 31st last only amount to £3,452 4s. 11d. There is, however, a large sum of £16,675 4s. 3d. put down as an asset, viz., 'sundry debtors in London and River Plate,' and having regard to the condition of things generally in the Argentine Republic, and to the meagre report, and to the carefully-worded certificate of the auditor, I think the shareholders ought to know something more definite as regards these debtors. One would like to know where they reside, and what proportion of the debts is due from those in London, and what amount is owing from those resident in the River Plate. As regards the former, who, no doubt, represent a comparatively small sum, this may be recoverable; but as regards the latter, and doubtless the largest amount—in the absence of further information—this item of assets assumes a dark and serious aspect."

Electricity versus the Horse in America. — The following is a copy of the July statement of the American West End Street Railway Company :—

	Total.	Electric.	Horse.
Gross receipts	$554,431	$144,552	$409,878
General expenses	27,613	6,955	20,657
Track and car expenses ...	179,853	43,891	135,954
Motive power	142,670	26,398	116,271
Total operating expenses ...	350,137	77,249	272,888
Net earnings	204,294	67,303	136,990
Miles run	1,497,568	377,191	1,120,377
Ratio mileage	100	25·19	74·81
Per cent. operating expenses ...	63·15	53·44	66·58
Earnings per mile run	37·02	38·32	36·58
Expenses per mile run :			
Motive power	9·53	7·00	10·38
Car repairs	·75	1·17	·61
Damages	·07	·12	·06
Conductors and drivers ...	7·91	6·92	8·23
Other expenses	5·12	5·37	5·07
Total expenses mile run ...	23·38	20·48	24·35
Net earnings mile run	13·64	17·84	12·23

The report for July shows a decrease of $7,965 in net earnings, as against June, but an increase of $88,359 over April, and $38,770 over May. Operating expenses for July are 63·15 per cent. for the system as it stands to-day, and while this in contrast with 61·37 per cent for June, the company can pay 10 per cent. upon its present common stock with operating expenses at 70 per cent. In April and May the motive power for a horse car cost 10·86 cents per mile, while in June and July it could not be brought lower than 10·38 cents. The motive power for an electric car has now been reduced to 7 cents per car mile, and will be lower in future.

A New Plate for Accumulators.—A new alloy of lead, very malleable, only slightly affected by acids, consisting of 945 parts of lead, 22 of antimony and 13 of mercury is, according to the *Revûe Industrielle*, being introduced by M. Worms for accumulator plates.

Combined Telephone and Switchboard.—A very useful and simple form of combined telephone and switchboard is being introduced by Mr. T. W. Ness, electrician of Montreal, Canada, for use in factories or warehouses where communication between various parts of the building are frequently necessary.

The Oerlikon Works.—The connection of Mr. C. E. L. Brown, who is well known in the electrical world, with the Oerlikon Maschinenfabrik, ceases at the end of the present month. At the same time M. Emile Hüber, of Zurich, joins the board of the company.

A High Telephone Line.—What is said to be the highest telephone line in the world has just been completed between Maniton and Pike's Peak, U.S.A., a distance of about nine miles. Pike's Peak, up which, it will be remembered, a mountain railway on the "Abb" rack system has recently been constructed, is 14,115 feet high, Maniton being also 6,563 feet above the sea.

The School of Electrical Engineering, Hanover Square.—Under the energetic management of Mr. Léon Drugman, and the able instruction of the senior instructor, Mr. Chas. Capito, this well-known school continues to keep up the high standard of reputation which it has earned. The school has now, as its consulting committee, Sir Samuel Canning, Mr. P. Herbert Carpenter, Mr. Gisbert Kapp, and Prof. Alexander Kennedy. The course of instruction, which originally was limited to 12 months, has now been extended to 18, no extra fees for the extension of time being charged. According to the syllabus, the courses arranged are as follows:—*Electrical Engineering* (*Lighting and Power Transmission*): The 18 months' course is divided into three terms of 20 weeks each, in three classes, called respectively the junior elementary, the senior elementary, and the advanced class. The passing from one class into the next higher one depends upon the passing of remove examinations. Each period of 20 weeks represents 500 hours. *Telegraphy and Telephony*: The 12 months' course is divided into two terms of 20 weeks each. An entrance examination is now imposed, consisting mainly of questions in arithmetic, euclid, and algebra. The school is well fitted with the necessary appliances for thorough practical instruction.

Alternating Current Dynamo Curves.—Amongst the interesting exhibits at the Frankfort Electrical Exhibition has been an apparatus of Dr. Frœlich for showing on a screen the curve of the rise and fall of current in an alternating dynamo. The apparatus consists of a large telephone iron disc with a small piece of looking-glass stuck on it eccentrically, and at the back is a horseshoe permanent magnet, the soft iron pole-pieces of which are wound with a coil carrying the current produced by an alternate current dynamo. The iron disc is therefore pulled more or less by the magnet, depending on the strength and direction of the current passing round its poles. A beam of light from an electric lamp is reflected from this mirror on to a screen, and as the alternating current flows round the magnet a vertical line of light is formed on the screen, the position of the spot of light on this line being at any moment a measure of the strength and direction of the current produced by the machine. Before the beam of light reaches the screen it undergoes a second reflection from one of a series of small plane vertical mirrors, arranged around the surface of a cylinder parallel to its axis. By suitable worm-gearing, the quick rotation of the dynamo causes a somewhat slow rotation of this cylinder, but quick enough to produce an apparently continuous horizontal beam of light along the screen, if there be no current flowing—that is, if the mirror on the telephone plate be at rest. The combination of the vertical and horizontal motions of the beam produces a curve which shows the shape of the current wave extending over some four or five periods.

A New Photometer.—A new photometer of the Bunsen type for use in laboratories has been devised by Mr. E. G. Wellyoung, and is being introduced by Messrs. Queen & Co., of Philadelphia, U.S.A.

A Private Installation.—Mr. Kemp Welch, of Sopley, has had his residence illuminated by the electric light for some time past. The river Avon passes by Sopley, and the water wheel for the old mill supplies the motive power for the production of the light.

Electricity in Printing.—The *Tirol Tageblatt* states that it is the first paper in Austria-Hungary and Germany to be printed by a press driven by electricity. This application is interesting from the fact that the motor, which is of the Ganz alternating type, receives current transmitted from the Innsbrück central station.

An Electrical Engineer's Failure.—A receiving order has been made against Charles James Allport, described as an electrical engineer, of Woburn Place, Russell Square. The debtor has submitted a statement of his affairs, showing unsecured liabilities £14,880, with assets £43. The Official Receiver states that, of the unsecured indebtedness, about £14,460 is in respect of money borrowed.

Newspaper Extract and Special Information Agency.—We are asked to announce the objects of this company, whose address will be seen amongst our advertisements. Official illustrated abridgments of all the latest patents issued in Great Britain, United States, Germany and Austria, can be supplied to subscribers on very moderate terms. This is the first attempt that has been made to deal with the literature of patents by means of Press cuttings, and we believe it is likely to prove very serviceable to those requiring copies of parts of specifications, without considerable expenditure of time and money.

The Electric Light at Brighton.—During the past week or so the Corporation electricians have been very busy, sometimes switching on as many as three and four new customers a day on to the mains. Up to the present the light has quite fulfilled the highest expectations, and burns with steady brilliance. One business house in particular is especially well illuminated. The windows, also the shops and show-rooms, workroom, warehouses, packing room, counting house, and other offices there, are all lit up with electric lamps of various sizes. The *employés* much appreciate the new illuminant, and state that the temperature of the place has been much lower since the installation was started.

Consulting Engineering.—Messrs. Hughes and Hill, of Manchester, write to us in the following terms:—"We note in your issue last week what you state to be a new departure in consulting engineering. It can hardly be characterised as a new departure, however, as we have ourselves already made offers of a similar character, viz., for fixed annual fee, to advise superintendents of installations on any points which may arise. We go a step further than this, however, and are prepared, for a fixed fee, to periodically inspect, test, and report on installations, test faults, look after breakdowns, &c. For this purpose we are providing ourselves with the best classes of instruments, which are too expensive for everyday installation work."

Popp Declines to Compete.—A correspondent in Budapest informs us that Victor Popp, of Paris, who has for some years solicited a concession for a compressed air installation, was recently invited by the Municipality to send in a tender for the electric lighting of the Hungarian capital. He now, however, informs the authorities that circumstances, which at the time of his application, were not in existence, compel him to abstain from the competition for supplying electric light and motive power in Budapest. A compressed air installation on his system, says Popp, can be profitable only if compressed air is used for generating electric current and for actuating industrial motors on an extensive scale. According to his experience, however, the prospects of profit in Budapest are not very enticing.

Closing of the Frankfort Exhibition.—The committee has definitely decided to close the exhibition on Monday, October 19th.

Omnibus Lighting.—It is again rumoured that the electric light will shortly be installed in the vehicles of the London General Omnibus Company.

Business Extension.—Messrs. Rashleigh Phipps and Dawson inform us that they have taken possession of their new manufactory for electric light fittings at Stanhope Street, Euston Road.

Electric Lighting in St. Petersburg.—The finest street in St. Petersburg is the Nevesky Prospect, which is about $1\frac{3}{4}$ miles long, and which is illuminated by means of electricity, the lamps being supported on 38 wrought iron tubular masts.

St. George's Vestry, Southwark, and the Electric Light.—The London Electric Supply Corporation, Limited, have addressed a letter to St. George's Vestry, Southwark, asking whether they are prepared to adopt the electric light in lieu of gas. The vestry has declined to entertain the proposal at present, on the ground of the difference in cost between the two methods of lighting.

The Old Students' Association.—The garden party organised by this association has never taken place, and now we learn that the annual dinner, arranged for to-morrow, has been postponed till October 31st. Who is responsible for the little eccentricities which appear likely to bring ridicule upon the management of this small body of budding engineers?

New Compound for Incandescent Lamps.—Messrs. Middleton and Akester, of 27, Munster Road, Fulham, S.W., say that they have invented a new compound, which, in its application to the outside of incandescent lamps, has several advantages over other compounds used for a similar purpose. This compound is luminous after the current of the lamp has been switched off, so that the lamp can be seen without any trouble. It also acts in the ordinary way as a ray diffuser.

Charlesworth, Hall and Company.—We are requested to announce that all communications for Messrs. Charlesworth, Hall & Co. should in future be addressed to their works and head offices, as Messrs. Ewen & Co., 37, Walbrook, E.C., no longer represent them.

Electric Light at Alnwick Castle.—The electric light at Alnwick Castle has now been at work sufficiently long to enable the Duke of Northumberland to judge as to the merits of the system, and he has now instructed Messrs. Drake & Gorham to introduce the electric light into his town residence.

The Electro-Technical Industry.—Electric light and telephone companies' shares have received some attention from the financial press this week. The *Financial News* of Tuesday called attention to the good prospects of electric lighting companies generally, and the Brush Company more particularly, and the *Financial Times* of the same day referred to the hopeful prospects of the National and Consolidated telephone companies. Whilst we regard the popularising of such securities with satisfaction, we do not quite like the selection of the shares of particular companies for special mention in financial leaders.

Fuses on Alternating Circuits.—It would seem from a discussion on a paper read in America last February, that the action of the alternating current has a disintegrating effect upon fuses, and causes them to blow after comparatively short use, and thus necessitates a constant renewal and supervision of the circuits. The author of the paper pointed out, as we have often done in these pages, that the electric light cannot be said to be perfect until operated in such a manner as to render interruption of the current, even for an instant, impossible. It is to be hoped that the time is shortly approaching when safety fuses will be relegated as things of the past, and that automatic circuit regulators, which do not necessarily interrupt the current, will perform all that is needful in controlling the electric light.

Eduard Taussig's Electric Smelting Apparatus.—With reference to the leaderette in our last issue on this subject, Mr. W. Maxwell sends us a specification of a patent taken out by him in 1886, in which a process is described, which is undoubtedly similar to that of Taussig's.

Liverpool Electrical Engineer.—Mr. J. C. Sherman has been appointed Electric Engineer and Inspector to the city of Liverpool, out of 93 applications, in succession to Mr. Charles H. Yeaman, resigned. Mr. Sherman has been trained at University College, Liverpool, and has been engaged on research work with Mr. Yeaman for the last three months.

The Electro-Harmonic Society.—This evening the 1891-92 season commences with a Smoking Concert, for which an excellent programme of high class music has been provided. Several new members are awaiting election, and we have every reason to anticipate another highly successful series of these welcome meetings, which seem to have touched the right chord in the hearts of the harmony-loving and hardly-worked electrical fraternity.

Tenders Wanted.—The Festiniog (North Wales) Local Board invite plans and estimates for the supply of electricity for lighting and power purposes to the village of Festiniog and district of Tan-y-Grisian. There is ample water power available. Plans and estimates should be sent before end of October, to Mr. R. Walker Davies, solicitor, Blaenau, Festiniog, North Wales, from whom all further information may be obtained.

Rescue from Drowning by an Electrician.—On Tuesday night Mr. Wm. Henry Patchell, an electrical engineer, residing at 90, South Hill Park, Hampstead Heath, rescued from one of the Hampstead ponds a young woman who was attempting to commit suicide. When the case was brought before the Divisional Court, the Chairman of the Bench complimented Mr. Patchell upon the prompt manner in which he had rendered his services.

A Substantial Dividend.—We publish in our City columns a report of the City Electric Lighting (Pioneer) Company, which is wound up in a manner most satisfactory to the shareholders. The company was formed with the object of disposing of the concession and the plant originally belonging to the Brush Company and the Laing, Wharton and Down Syndicate. This has been done, and the new City Electric Lighting Company become the owners, at a cost of £75,000. This substantial sum enables the Pioneer Company to return its shareholders 50 per cent. upon the capital invested.

Proposed Electric Traction for Edinburgh.—The Lord Provost's Committee of Edinburgh Town Council had on Wednesday before them a letter from Mr. R. Addison Smith, S.S.C., regarding the proposed erection of a temporary overhead electrical system for traction of the cars on Leith Walk. The application to the Town Council emanated from an electrical engineer in London, who wished to get the authority of the Corporation to erect the wires, the object being to demonstrate the fact that cars can be worked on steep gradients by electricity, and to obtain data relative to the cost of overhead wires as compared with underground ones. It was ultimately agreed not to grant permission for the experiments.

Benham and Froud.—Messrs. Benham and Froud, of the Chandos Works, Charing Cross, have just issued a new catalogue of electric light fittings, consisting entirely (with only four insignificant exceptions) of their own new and original designs. The book contains drawings of a great variety of artistic fittings beautifully reproduced in lithography. They have also a catalogue of wrought iron work, all the patterns in which are also novel and original, many of them, though not designed specially for electric light, being capable of easy adaptation. The house of Benham and Froud, which was established in 1785, was entrusted with the making of the golden ball and cross of St. Paul's Cathedral, and has adopted as its trade mark a representation of that exalted object. Though old, however, the firm is not antiquated, but is keeping abreast of the times as regards changing requirements in the matter of fittings.

A County Council Contract.—The contract for the lighting of the Newington Weights and Measures Offices for the London County Council has been given to Messrs. Drake and Gorham.

St. Cecilia Orchestral Society.—We have received a circular from our friends of the above Society (Central Telegraph Department), announcing the commencement of their 1891—92 season. Though the orchestra numbers upwards of 60 performers, the St. Cecilians will be pleased to welcome any instrumentalists connected with the Telegraph service or any branch of the electrical profession. Communications may be addressed to Mr. Arthur Crudge, hon. sec., or to Mr. Alexander McEwan, hon. treasurer, Central Telegraph Department. We hope to hear of the continued prosperity of this useful Society.

Crystal Palace Exhibition, 1892. — The Electric Installation and Maintenance Company, Limited, who are the undertakers under a provisional order, confirmed by Parliament, for supply of electricity to the Crystal Palace and district, have arranged for transmitting from their generating station (which Messrs. J. E. H. Gordon and Company, Limited, of 11, Pall Mall, London, are now erecting for them at Sydenham), to the Crystal Palace about 500 H.P. of electrical energy for the convenience of exhibitors requiring power for working motors, lighting, battery charging, electrolysis, and experimental and other purposes. The current will be continuous, and will be supplied at a pressure of 1,000 or 100 volts by special arrangement, and will be delivered at the exhibitor's terminals nearest to the company's mains in any part of the Crystal Palace. The charge for energy so supplied will be by meter, at 6d. to 8d. per Board of Trade unit, according to the guaranteed minimum consumption. Contracts will be entered into for the supply of pre-determined amounts of energy during specified hours, and in such cases the current will not be passed through a meter. Mr. R. Applegarth, 11, Queen Victoria Street, will furnish any further information and afford every assistance to exhibitors requiring current. Early applications are necessary, as the supply of current will be limited to the stated quantity.

NEW COMPANIES REGISTERED.

Josiah Wade, Limited. — Capital £20,000, in £10 shares. Objects: To acquire and carry on the business of manufacturer of the Anglo-American "Arab" printing machine, now carried on at Crown Works, Hopwood Lane, Halifax, and 17, Cable Street, Liverpool; to carry into effect an agreement for the purpose, and to carry on the business of mechanical and electrical engineers, machine and tool makers, iron and brass founders, &c. Signatories (with 1 share each): J. and Mrs. Wade and Miss J. Thompson, 20, Rhodes Street; W. Glendenning, 3, West View; T. Kendall, 42, St. Mary Street, Hopwood Lane; J. Robinson, 55, Garle Mount; and G. M. Riley, Savile Lea, Savile Road; all in Halifax. J. Wade and G. M. Riley are the first directors, the first being governing director. Registered on the 22nd ult. by Godfrey, Rhodes, Frith & Co., 77, Chancery Lane, W.C. Office, Crown Works, Hopwood Lane, Halifax, Yorks.

Law's Electrical Appliances Company, Limited.—Capital, £4,000 in £5 shares. Objects: To enter into an agreement between E. F. Law, of the first part, C. T. D. Crews, S. Macleay, J. T. F. Otway, W. H. James, and E. F. Law, of the second part, and the company of the third part, and to work and develop the inventions, patents, and rights intended by such agreement to be sold to the company. To enter into an agreement with William Clowes and Sons, Limited, and to carry on the business of type-setters and compositors by machinery, printers, telegraphists, &c. Signatories (with one share each: S. H. Isles, 89, Bethune Road, Stamford Hill, N.; W. D. Christmas, Modelle House, Tottenham; F. Alder, 34, Santos Road, Wandsworth; E. C. Davidson, Box Cottage, Twickenham; W. M. Gannington, 72, Mark Lane, E.C.; W. S. Crooks, 7, Kensington Park Gardens, W.; W. Harris, 136, Drayton Park, Highbury. The number of directors is not to be less than three nor more than six; the first being Major E. F. Law, S. Macleay, J. T. F. Otway, and S. H. Isles. Registered on the 23rd ult. by Davidson and Morris, 40 and 42, Queen Victoria Street, E.C.

Atlas Carbon Manufacturing Company, Limited.—Capital £2,000 in £1 shares. Objects: To manufacture, sell and deal in carbons, glass, India-rubber, vulcanite, iron, copper, electric conductors, and all machinery, plant and appliances necessary for the generation, distribution, accumulation and employment of electricity. To enter into an agreement with W. J. Woodward, and to enter into any contracts for the supply of electric light, heat and power. Signatories (with 1 share each): F. H. Judson, Babington Road, Streatham; W. H. Moody, Fairfield Dale, Park Road, Upper Norwood; F. Jackson Lethe, 19, Ewer Street, Southwark; G. N. Spyer, 52, Warlock Road, Westbourne Park, W.; S. Randall, 78, Arthur Street, Brixton; H. Upton, 77, Southwark Street; A. Scott, 162, Walworth Road. Registered, without articles of association, on the 24th ult., by Slaughter and May, 21, Great Winchester Street, E.C.

LEGAL.

Electric Arms and Ammunition Syndicate.—Mr. EUSTACE SMITH presented a petition by J. Watson and others, in the Vacation Court, before Justice Jeune, on Wednesday last, for an order winding up this undertaking, incorporated for the manufacture and sale of firearms to be discharged by electricity. The petitioners complained that their money was being expended, not in the manufacture of arms, but in certain experiments with respect to the battery.

Mr. MILLAR, Q.C., for the company (interposing), remarked that the bulk of the shareholders agreed with the directors that it was desirable these experiments should be made in order to test the capabilities of the patent. The directors objected to ruin being brought upon the undertaking by five shareholders, who have not met their own obligations to the company.

Counsel appearing on behalf of 49 shareholders, strongly opposed the application.

Mr. MILLAR suggested that the petition should at least stand over until after a meeting of shareholders called for the 9th of October.

Mr. EUSTACE SMITH said the result of the meeting might be anticipated, as £21,000 had been issued in fully paid-up shares to the vendor, and only £8,000 had been taken up by the public.

His LORDSHIP said the petition had better stand over for a fortnight.

Re Ifah Williams.—A first sitting was held on 24th inst., in the High Court of Justice, Queen's Bench Division, before Mr. C. A. Pope, under the failure of the debtor, Ifah Williams, against whom a receiving order was made on the 3rd inst., upon the petition of the General Electric Power and Traction Company, Limited.

With reference to the assets, it was stated that General Williams had a power of appointment in the debtor's favour of the sum of £4,000, but he was not prepared to exercise it.

A resolution was passed in favour of bankruptcy, Mr. Ernest Collins, accountant, being appointed trustee of the estate, with a committee of inspection.

CITY NOTES.

The Brush Electrical Engineering Company, Limited.

THE second annual report of the directors to be presented to the shareholders at the general meeting of the company on September 25th, 1891, has been issued. It states that the profit and loss account shows a gross profit of £42,712 8s. 10d., inclusive of the amount brought forward from last account, but exclusive of any profit derivable from the City of London electric lighting undertaking. After deducting all standing charges, &c., maintenance of plant, buildings and patents, and interest on debentures, there remains a balance of £19,354 2s. 1d. It is proposed to apply £630 to reduction of preliminary expenses, and to reduce property, patents and goodwill account by £3,000. An interim dividend, absorbing £4,199 15s. 2d., has already been paid upon the preference shares for the six months ended December 31st last, and it is proposed to apply £4,199 15s. 2d. to the payment of a further dividend upon these shares, making up the full preferential dividend at the rate of 6 per cent. per annum. The directors further recommend that a dividend be paid upon the ordinary shares of the company at the rate of 6 per cent. per annum for the half-year ended June 30th last, and that the balance of £306 11s. 5d. be carried forward to next account. It is proposed to make the dividends on both the preference and the ordinary shares payable on October 1st next.

The accounts include the returns from the Australasian branch made up to April 30th last. The business of the branch is now established on a satisfactory basis, and the result of the working shows a small profit.

The capital account has during the year been increased by £5,000, being the amount of fully-paid shares issued to the Australasian company in completion of the purchase of their stores and other assets in Australia.

	£	s.	d.
The property account stood at the date of the last balance sheet (after writing off £3,000) at... ...	294,400	8	10
During the year the account has been increased by—			
Proportion of shares issued to the Australasian company, and cost of establishing branch £1,918 10 6			
Additions to buildings, plant at Loughborough and other places 5,226 2 4			
Expenditure on new patents and developments 564 2 1			
	7,708	14	11
	£302,109	5	9
The account has been reduced by—			
Sales of properties, amortisation of leases and proportion of compensation received from South Eastern Railway £13,294 3 3			
Amount this year included in balance sheet of foreign and colonial branches 22,544 2 8			
	35,838	5	11
The account now stands at	£266,270	19	10

During the past year sums amounting to £21,070 18s. 1d. were expended upon the City of London Electric Lighting undertaking, arrangements having been made with a provisional company called the City of London Electric Lighting (Pioneer) Company, for the carrying on of the work. Since the closing of the books the whole of the interests of the Brush Company in the City of London electric lighting undertaking have, with the consents of the Board of Trade and the Commissioners of Sewers, been transferred to a larger company called the City of London Electric Lighting Company. As, however, the transfers were not completed until August 21st, no profits on the large amount of work done have been included in the profit and loss account to June 30th.

In consideration of this transfer the Brush Company has received contracts for the equipment of the central stations, amounting in the aggregate to over £300,000, to be executed by instalments, as specified by the City Company. A satisfactory profit will accrue from the carrying out of these contracts, and an amount of about £53,650 is now payable to the Brush Company on account, in addition to £25,700 already received.

A strip of land adjoining the Lambeth works has been sold to the South Eastern Railway Company in consideration of the payment of £6,500. A portion of this amount has been applied to reduction of property account, and the balance has been placed to a reserve account to meet the expenses caused by the disturbance. The main factory premises will not be affected by this sale of land, but the present office accommodation of the company will be much curtailed, and the board have decided to take the opportunity of removing the head offices to the City.

The Bournemouth undertaking, consisting of provisional order, land, buildings, and plant, has been transferred to a local company in consideration of the sum of £17,275 which has been paid partly in cash and partly in fully-paid shares of the company, and the stores have been sold for cash at a valuation. As part of the arrangement, this company has guaranteed a minimum dividend of 5 per cent. per annum for three years upon the capital of the company, not exceeding £30,000. The profit on the sale has been placed to the reserve account.

The Austro-Hungarian business continues to increase and to give satisfaction, and the new factory at Vienna will shortly be completed. The negotiations for a re-arrangement of the company's interest in the business are still pending.

The volume of the company's business in the manufacture and installation of electrical apparatus and in the construction of steam engines, and of rolling stock generally, continues to increase, and the prospects for the current year are encouraging. Besides the work to be done for the City Company, several other important contracts have been secured which should result in profits to the shareholders.

The large amount of work in hand and in view, has demonstrated the wisdom of acquiring and extending the Falcon Works, as without these additional manufacturing facilities the company would not have been able to undertake the carrying out of these large central station contracts.

Owing to pressure of other engagements, Lord Thurlow felt compelled to resign his seat at the board and the chairmanship of the company, and his Grace the Duke of Marlborough has succeeded him as chairman. The directors also regret the retirement from the board of Mr. John S. Sellon, on account of his health. Mr. E. Garcke, formerly manager and secretary, has been appointed managing director. The Duke of Marlborough and Mr. Sanderson retire by rotation and offer themselves for re-election.

Messrs. Cooper Brothers & Co., the auditors, offer themselves for re-election.

BALANCE SHEET, June 30th, 1891.

Dr.	£	s.	d.
To Authorised capital	750,000	0	0
„ Capital issued, viz.—			
69,996 6 per cent. preference shares of £2 each, £139,992; 77,978 ordinary shares of £3 each, £233,934; less calls in arrear, £2 10s. ...	373,923	10	0
„ 6 per cent. mortgage debentures	75,000	0	0
„ Creditors—			
Sundry creditors	41,630	14	4
Bills payable	18,898	4	10
„ Advances from City of London Electric Lighting (Pioneer) Company and others against City undertaking	34,892	15	7
„ Reserve account	4,275	16	2
„ Balance of profit and loss account (less interim dividend paid on preference shares, £4,199 15s. 2d.)	15,154	6	11
NOTE— Contingent liability in respect of uncalled capital on shares in other companies, and on bills receivable discounted £10,886 8 4			
	£563,775	7	10

Cr.	£	s.	d.
By Property, patents and goodwill. For value of plant, freehold and leasehold land and buildings at Loughborough in Leicestershire, at Lambeth, Borough Road and Hammersmith in London, at Edinburgh, Cardiff and Manchester, and of English, foreign and colonial Brush, Edison and other patents, and of goodwill of the Anglo-American Brush Electric Light Corporation, the Falcon Engine and Car Works, Limited, and the Australasian Electric Light and Power Company	266,270	19	10
„ Stock. Goods in hand in process of manufacture, and materials at London, Loughborough and other places	78,326	6	3
„ Debtors.			
Sundry accounts (after provision for doubtful debts)	87,641	10	1
Bills receivable	5,621	11	9
„ Cash at bankers, and in hand	7,062	3	11
„ Shares and debentures in other companies ...	28,914	0	0
„ City of London Electric Lighting undertaking ...	21,070	18	1
„ Provisional orders account	989	4	0
„ Preliminary expenses, 1889-90, less written off last year, £625	1,261	15	8
„ Liquidators' balances and suspense accounts ...	2,086	13	3
„ Balance of foreign and colonial branches accounts, being excess of assets over liabilities	64,530	5	0
	£563,775	7	10

APPROPRIATION ACCOUNT.

Dr.	£	s.	d.
To Further dividend on preference shares	4,199	15	2
„ Dividend on ordinary shares at the rate of 6 per cent. per annum for 6 months	7,018	0	4
„ Reduction of property account	3,000	0	0
„ „ of preliminary expenses	630	0	0
„ Balance carried forward	306	11	5
	£15,154	6	11

Cr.	£	s.	d.
By Balance	15,154	6	11

PROFIT AND LOSS ACCOUNT for the year ended June 30th, 1891.

Dr.	£	s.	d.
To General charges, viz.:— Directors' fees, £1,875; auditors' fees, £52 10s.; salaries, £7,222 7s.; staff bonuses, £759 7s. 9d.; law charges, £584 18s. 1d.; insurance, £770 14s; postage, stationery and printing, £1,282 8s. 10d.; travelling, carriage and freight, £652 2s. 4d. advertising, agency and sundries, £2,238 14s. 1d.; income tax, £348 15s. 3d.	15,786	17	4
„ Share and debenture expenses	108	18	0
„ Loss on closing Cardiff station	447	7	3
„ Maintenance of plant and buildings	2,184	17	7
„ „ patents	478	19	2
„ Interest on debentures to June 30th, 1891 ...	4,351	7	5
„ Balance, being net profit	19,354	2	1
	£42,712	8	10

Cr.	£	s.	d.
By Balance from last account	2,796	14	9
„ Gross profit, including net profit of foreign and colonial branches	39,915	14	1
	£42,712	8	10

BALANCE SHEET OF THE FOREIGN AND COLONIAL BRANCHES.

Being the Balances of the following Accounts:—Vienna (made up to December 31st, 1890), Temesvar (made up to June 30th, 1891), Australia (made up to April 30th, 1891).

Dr.	£	s.	d.
To Creditors—			
Open accounts and bills payable...	26,967	10	4
Unpaid balance of purchase price of land secured by mortgage	7,505	6	8
„ Balance of assets over liabilities transferred to general balance sheet	64,530	5	0
	£98,303	2	0

Cr.	£	s.	d.
By Property—			
For freehold and leasehold lands, buildings, plant, tools, fixtures, &c., at Vienna, Temesvar, and in Australia	36,820	1	11
„ Stock—			
For goods in hand, in process of manufacture, and materials	33,246	7	10
„ Debtors—			
Sundry accounts (after provision for doubtful debts) and bills receivable	27,205	5	4
„ Cash—			
At banker's and in hand	828	17	4
„ Shares in other companies	10	0	0
„ Australian suspense items	192	9	7
	£98,303	2	0

THE second annual general meeting of this company was held at Cannon Street Hotel, on Friday last, the Duke of Marlborough presiding.

The SECRETARY, Mr. B. Broadhurst, having read the notice convening the meeting,

The CHAIRMAN said: It is a somewhat difficult position that I occupy here to-day, as I have only assumed the position of chairman of the company for a broken year. I have had the pleasure of being connected with the company for three years, and have watched its progress and seen the difficulty that it had to contend with, and when we, unfortunately, lost the valuable services of our late chairman, the shareholders were kind enough to ask me to carry on the business of the company as chairman for the remainder of the year, and that duty I was very pleased to accept. Perhaps, personally, it is a fortunate circumstance for me that I am able to bring to your notice so favourable a balance sheet as that now placed before you. It is many years since the company had been able to feel that its position was one of commercial stability, and therefore it is a very fortunate circumstance to myself that I should be, as it were, the spokesman of the company's very much improved conditions. The history of your company is a peculiar one, and, as you are aware, it was founded in the year 1879, and had been about 12 years in existence. At that time there was an idea that the electric light was going to sweep away all the gas companies and, in fact, completely revolutionise the conditions of our home and of our industries. That anticipation was not fulfilled. They found out, as electricians could have told the public at the time, that though there was great hopes for the future, hundreds of problems still remained unsolved, and not only in regard to the problem of electric lighting energy itself, but also with regard to its distribution, it would take years before they could really place this industry on a commercial basis. Now, gentlemen, in the inception of your business you had many valuable patents, which you sold for large sums, and your dividends were enormous. One year you absolutely paid over 100 per cent. dividend. Well, it was not to be supposed that such a state of things as that could have existed without turning men's heads, and really going beyond the limits of prudent enterprise, the consequence was that in very few years the Brush Company got into considerable difficulty, and I think it was Sir Henry Tyler, who was then chairman, resigned. At that time Lord Thurlow became the chairman of the company, and it really was a terrible time to have undertaken the chairmanship of the board, and the direction of the affairs of the company. Not only were there the discouragements which had been created by the failure of early promise, but there was the extreme difficulty created by the character of the early electric lighting Acts which were of such a nature, that it was impossible to capitalise undertakings, when there was no security to shareholders against being bought out at a price which would not repay them for their investments. To amend the Acts was quite an undertaking. The late chairman, Lord Thurlow, in conjunction with other gentlemen, was largely instrumental in getting those Acts amended, and in getting the present Acts passed. In fact, it was owing entirely to the amended Electric Lighting Act that the electrical industry had become possible in this country in the form of public lighting. I think, therefore, that we owe our late chairman a great debt of gratitude for having, perhaps somewhat unobtrusively, in the House of Lords worked this question as he did, and having carried through the affairs of this company for four or five years at a time of considerable depression when we were able to pay no dividends. I think it was only in one year—in 1885—that a dividend was paid at all, and so matters went on, and you are aware it became necessary to reconstruct the company. That period had now passed, and I am able to put before you quite a different prospect for the future. The turning point in the affairs of the company was, first of all, its reconstruction, and secondly, the amending of the Electric Lighting Acts. The object of the company was not to do small—what he would call retail work—but large industrial enterprise. Electrical energy had many features and many sides. There is traction and mining, and various ways in which energy called electricity can be employed; but the principal object and reason of the company was for the purpose of developing electric lighting centres. Now you are going to have immense demands for the establishment of these large electric companies. What the gas companies did in former times, the electric lighting companies are going to do in the future, and therefore there is a large field open for such a company as ours. The obtaining of those Electric Lighting Acts was invaluable to the development of that industry. In order to be able to carry out that work, the directors decided that it would be very advantageous to obtain some very large manufacturing premises, and negotiations were carried out, and by means of which you obtained the Falcon Works at Loughborough. Your directors have visited these works on several occasions, and have great pleasure in reporting that you are possessed of splendid manufacturing works, where you can make dynamos and engines on a large scale, in fact, as large as any electrical works in this country. They have begun in a conservative spirit, and as the industry develops I am sure you will approve of them being extended, so that I might say that the particular feature of your enterprise is that you are looking forward to securing large and important orders for carrying out electrical centres, and at the Falcon Works you are able to manufacture plant for carrying out those enterprises. The policy, in fact, has been to concentrate our energies and get rid of outside obligations. I will turn my remarks to one or two small features which had been placed before you. Another of your directors (Mr. Braithwaite) will speak later on the subject of the report itself, and analyse to you the particularly favourable character, financially, of those figures. The only point that it is my duty to insist upon is that this balance sheet includes nothing except what is fair honest trading profit for the year. There is no profit from the City undertaking carried into this year's report, neither anything connected with the sale of the Bournemouth station, nor with regard to monies we have received for sales of certain land to the South Eastern Railway. It is simply nothing more than a trading account in which this year you have made gross profits £39,915, as compared with £36,698 for last year. Now then I think this, in a natural course, brings me to say a few words about the City undertaking, and perhaps our shareholders do not all realise what an extremely important thing this is. Probably there is no undertaking in the whole of Europe which presents an exact parallel to the undertaking which you are concerned in carrying out. This is the only town, as far as I am aware, where the whole of the private and public lighting has been entrusted to one electric lighting company for a period of 40 years' monopoly. If you consider what is the condition in other parts of London where provisional orders have been given, you will see what an advantage it is. In every other district the Board of Trade have decided to give two provisional orders, one for the continuous current system and the other for the alternate current system. This is undoubtedly, in the long run going to create the most complete confusion and disappointment to shareholders. What will take place is this: one company will start with one system, and when they have gone a certain way towards lighting a district, another company will be formed, having obtained a provisional order for the other system, and then there will be a competition, but not a fair competition, but a competition of the character of trying to bounce one system by threatening it with competition from another. The reason why it cannot be a fair competition is that the streets of a town like London do not admit of laying two sets of cables; that is to say, when you have laid out—plotted out—a system of cables necessary to supply from a central source of energy, you cannot find room to lay another network. It is exactly as if you had two telegraph companies trying to run their wires over the same district, which must result in confusion. You have nothing of that sort in the City; you have got a perfectly clear field, and the City company enjoys the monopoly so long as it fulfils its duty. You will see what great assistance that will be to this company. We are interested in this business to the extent of two-thirds; that is, the City having been divided into three parts, we have got two parts, and another group of gentlemen, who are representing an American firm of some position—Messrs. Thomson-Houston—have obtained the other portion. However, that is nothing to do with us at the present moment. All I have to point out is, that we are interested in two-thirds of this large undertaking, and if the City of London Company succeeds in carrying out their work satisfactory, and avoiding the mistakes which were unfortunately made in earlier enterprises, you will get the credit of the success, and that must eventually lead to the development—

which I pointed out before—of the central lighting business, which is the main feature of our industry. I cannot impress upon you too strongly what an immense advantage it is to have obtained this valuable order, and in passing I must say that I think you ought to know that you owe that entirely to the services and persistent labour of your managing director, Mr. Garcke. Although your board have given every attention they could to the affairs, it would have been impossible for them to have negotiated this enterprise. Mr. Garcke, for several years, has been working on this project, and he has succeeded in carrying it to a satisfactory conclusion. It is also largely owing to his successful labours that in this intance we are able to come forward and make such a very favourable report, not simply with regard to the balance sheet, but the prospects of the company generally. The next point that I must allude to is the Bournemouth central station. You are aware it was considered advisable to establish a business at Bournemouth for the purpose of demonstrating what the electric light could do. There has been so much ignorance in former times concerning electricity, and there has been the necessity of pushing the industry, that we were puzzled at times to know what policy to adopt, and in the interests of the company we successfully opened a station at Bournemouth. We did this by obtaining a provisional order; the company carried on the work themselves. But, in the opinion of your board, this was an unsatisfactory position for a manufacturing company to be placed in, and we thought it would be more advisable if we could realise the values there locked up, and free our hands. Negotiations were set on foot which ended in floating the Bournemouth company, whose terms were not unprofitable to us. We reaped a fair profit on our plant, the payment being £17,275, partly in shares and partly in cash. We are thus free from any difficulty and any engagement with regard to Bournemouth, and the matter is now in the hands of a board composed of gentlemen who have a local interest, and the intelligence and energy to make that business succeed. The capital of the company formed there is £30,000, and your company have guaranteed a 5 per cent. dividend on that for a period of three years. I do not think, judging from the returns, and the demand for the electric light at Bournemouth, that you are really incurring any risks in giving that guarantee. I now come to another feature of our industries, our business at Vienna and Temesvar. At one period during the past five years it was considered advisable to acquire the Vienna business. It was acquired at a very low price, and a great deal of time and energy has been devoted to developing that business. We have a factory which, although it is of a temporary character, will soon be increased by the addition of permanent works which are in process of erection, and, in fact, they are nearly finished, and a large business is being done there. Temesvar is a place situated like Bournemouth, where we undertook the lighting of the town, and we are still carrying out that business. Negotiations are going on, and with regard to the Temesvar and the Vienna factory, which will very likely end in your company disposing of those two industries on favourable terms. There is a great deal to be said against what I call the long-armed management, that is, trying to manage such a thing as an industrial enterprise abroad, especially at the distance of Vienna. Where you are interested as sleeping partners, you need not fear for your capital; but where you have to manage the thing yourself, and are responsible for all the expenditure and all the mistakes, you cannot manage an industry such as the electric light business is in a country like Austria as successfully as people who are on the spot. I have no hesitation in saying that if an arrangement can be carried through financially advantageous to yourselves, by which you can dispose of this business which has grown largely during the time it has been in your hands, you will be adopting a wise and prudent course. Negotiations went on with the South Eastern Railway with regard to the portion of the ground in which our Lambeth works stood, and it has resulted in an agreement for the sale of a portion of the strip of land. The money has been paid, but, unfortunately, the selling of that strip of land has interfered with some of the offices of the company, and we have therefore been obliged to take offices for the Board and commercial department elsewhere. Those offices are situated in Queen Victoria Street, near the Mansion House Station, so that for the next few years you are possessed of those offices on lease; here will be carried on the commercial part of the concern. Meanwhile the factory works at Lambeth will remain as they are, so far as the construction department goes, and the technical draughtsmen's offices, &c. I now come to the question of Australia. As you know, you have a branch of business in Australia, and a great deal of trouble and thought has been devoted by the board, and by your managing director, to the development of this industry. We have a manager there—Captain F. Rowan—who does all he can to develop our interests on that side of the world. It might seem that there was not a great deal to be gained at present by establishing such a branch of our industry; and yet, when we think of it, we must see that we cannot expect our colonies to develop this new business unless we go in and start it. There is no doubt that the colonies will largely require these things which we can provide for them. Although there may not be a very large demand at present, there is a satisfactory demand springing up, and the business will undoubtedly grow, and I think you will in a few years time hail with great satisfaction the fact that your board were inspired with the idea of getting early into the Australian field, and get a large amount of the custom of our cousins. Therefore, though the profit on the first year's working is not large, it affords us an indication to what the working of this business may eventually come, and I think we may fairly look forward with great hopes to the development of a very considerable business in Australia and the colonies in the course of the next few years. We are really only at the commencement of this marvellous science. More than 10 years have gone by, and manufacturers on the one hand, and men of science on the other, have been trying to thrash out this question of electricity. It has been in the hands of the mathematicians, and "chucked" at the heads of the engineers next, but now we are getting out of that. Both engineers and the practical men—men of business—and the professors, have practically come to the conclusion that we now know exactly where we are moving. It is simply therefore a question of expenditure. When the public can afford to put up the money to form companies for the lighting of their towns by electricity, we—the Brush Company and other companies—are absolutely in a position to solve the problem for them, there is no doubt about. Ten years ago, when this company paid its 100 per cent., it was not in that position. To-day you have a business established on a commercial basis. Your directors do not at all recommend that the thing should be pushed or boomed in any way, but on the other hand they feel the greatest confidence that it is simply a question of time and a question of expense; when we shall be able to get any quantity of orders we require, and we shall be able to do a thoroughly good business, remunerative in every sense of the word to the shareholders of this company. I feel no hesitation, therefore, in speaking in the most hopeful way with regard to the future. I may say just in passing that, as compared with the average of the five years preceding, the volume of business has increased in the ratio of 100 to 288, that is nearly 200 per cent., while standing charges have only increased in the ratio of 100 to 113, or 13 per cent. Therefore you will see that the policy of your board has been to keep down expenses as far as possible, and not to let them run ahead of the business. These standing charges have stood, practically, stationary, while the business has largely increased. I may conclude by saying that you have before you every prospect of a successful year, and next time we meet we hope to be able to present quite as prosperous a report as the one laid before you. You are aware that not only have we lost the services of Lord Thurlow as chairman of this board, but we have lost also the invaluable services of Mr. John S. Sellon, who for many years was connected with this company. It is with regret that this company's directors have lost his help; but he was unable, owing to the many engagements, to continue his personal attention to the affairs of the company. I move: "That the report of the directors and statement of accounts to June 30th, 1891, as now presented to the shareholders, be received, and the same be hereby adopted."

Mr. J. B. Braithwaite then seconded the adoption of the report, and called attention to one or two changes which had taken place in their balance sheet, and one or two features of interest. He stated that the report was purely a trading balance. It was in no degree a speculative one, and the results shown were entirely from ordinary trading. There was not one penny of profit to be made in connection with the City of London orders, that was all in store for them in future years, nor had they taken in any of the money received for the sale of properties. He thought it was a very favourable balance sheet, and they might look forward with considerable satisfaction to any future balance sheet that they might have presented to them. He referred to the staff bonuses which had now been given to the principal officers of the Brush Company, and they hoped ultimately to extend it to every man who had been two or three years with the company, and who had proved himself deserving. Considering the nature of their industry, and that the quality of their manufactures of dynamos and engines depended so very much upon the individual care of their workmen, he thought it was a good policy, in their interests, to give every man an interest in the company. It was the best way to prevent strikes amongst the *employés*. The speaker referred to the closing of the Cardiff station, which was owing to the fact that the local authorities would not give their consent to a provisional order. After a few other remarks, Mr. Braithwaite formally seconded the report which was carried unanimously.

The next business was the re-election of the Duke of Marlborough as chairman, and Mr. Aymor H. Sanderson as director. This having been carried, the re-election of the auditors, Messrs. Cooper Bros. and Co., and a vote of thanks to the chairman, terminated the proceedings.

The Direct Spanish Telegraph Works Company, Limited.

The thirty-sixth ordinary general meeting of this company was held on Tuesday last at Winchester House, Old Broad Street, E.C., Mr. Edmund Etlinger presiding.

The Manager (Mr. Charles Gerhardi) having read the notice convening the meeting,

The Chairman stated that, before commencing the business, he had to announce with the utmost regret that the absence of their chairman (Sir James Anderson) was caused by a sad domestic affliction—probably the greatest affliction that could have fallen upon him—Lady Anderson having died on Friday last. Mr. Etlinger said that they felt sure that every shareholder in the company would feel the greatest sympathy with the chairman in this great loss.

The minutes of the last meeting were then read, and

The Chairman proceeded to make one or two observations on certain paragraphs. He stated that the traffic receipts show a decrease of £1,620 10s. 6d. as compared with those of the corresponding half-year in 1890, and he was bound to say that this paragraph did not quite do full justice to the company's position. It was absolutely true that they had lost £1,620, or rather made less revenue than in the previous corresponding half-year, but he must explain that the year 1890 was quite an exceptional year in their history. Ever since the Berlin tariff came into operation in 1886 they had had a regular, steady increase in their receipts, in fact, so regular, that they could see that there was a normal increase year after year, and that normal increase went on until 1890, but in that year, for reasons which it was unnecessary to go into, there was an enormous increase

and the normal increase was not exceeded slightly, but three times over. He thought they must exclude the year 1890, otherwise they would not have a fair conception of the position the company occupies. They would remember that in 1889 they had a very good year, and the present half-year far exceeded their receipts in 1889, but was behind the exceptional year 1890. 1889 was better than 1888, 1888 was better than 1887, and 1887 better than 1886, and it had stopped there, because that was when the Berlin reduced tariff came into operation. This present half-year showed larger receipts than any other since the commencement of the company in 1873, with the exception of the year 1890. The company was in a very healthy position, with the exception of showing a decrease from the year referred to. The question was, how they would get on for the future. There was no doubt that their value of traffic would keep on increasing, but as they were aware, the Paris Conference have again reduced their tariff, and therefore from the moment this new tariff came into operation (July 31st, 1891), the company started a new position. They did not know how the reduction of ½d. per word would affect them. In the first place one would suppose naturally that if people could telegraph at a cheaper rate, they would telegraph more. If, because of the reduction, people chose to increase the number of words in their telegrams for the sake of clearness, the company would be in the same position as before; but it was impossible to say how far the reduction would influence people. Another idea was that coding was based upon the principle of saving expense, and as the word tariff was now being made extremely low, it was hoped that the time would soon arrive when people would not take the expense and trouble of coding; consequently the reduction of tariff would tend to diminish this coding business, which was a trade that the telegraph companies suffer from very much. The next matter referred to was the working expenses, which were £284 17s. 9d. in excess of those of the corresponding period of the preceding year. The speaker explained that £100 out of this amount was the sum voted by the shareholders at the last meeting to the directors, as an additional remuneration in the way of salary, making it £200 per annum, instead of the directors sharing the profit of the company. The remaining £184 was, grossly speaking, the value of the additional assistance which they required in the stations in order to carry on the immensely increased traffic, and to attend to the duplex working. Whilst mentioning the duplex working, the Chairman stated that this was in full operation, and working remarkably well. The company were in a position which enabled them to transmit a message from London to Falmouth in three minutes, and a message from London to Madrid in twenty minutes. In further remarks, the Chairman stated that the cables and instruments and general property were kept in very good order, thus proving that their manager and staff did their work admirably well. The next item was the cost of the repairs to the Barcelona cable, which amounted to £1,695 1s. 2d. The Chairman said that there was a remarkable statement to be made in this case, that where the cable parted, their own Barcelona cable which had been under water since 1884, had been found in a very perfect mechanical position, and was almost as good, mechanically, as it was when laid down originally, and they were in hopes that it had a long life before it. He thought they owed thanks to the Eastern Telegraph Company for the promptness with which they at once put at the company's disposal one of their vessels to enable them to repair the break referred to, and the interruption only lasted ten days, whereas some years ago when a breakdown occurred they had sometimes to spend weeks before they could get a ship. Out of the balance of the half-year's profits they had placed £2,500 to the reserve fund, and they recommended the payment of dividends at the rate of 10 and 5 per cent. per annum, respectively, on the preference and ordinary shares. After paying this they had a small balance of £270 4s. 10d. in hand, which they propose carrying against the contingencies fund. They could have paid 6 per cent.—that is, one per cent. more—on the ordinary shares by appropriating this £270, but they thought that would have done them a great deal more good than harm, it being so necessary to have money in hand to meet contingencies. The Chairman then proposed, and Mr. John Denison Pender seconded, and it was carried unanimously, that "the report and accounts now presented are hereby received and adopted."

Mr. BARNET (shareholder) proposed that a vote of condolence with Sir James Anderson and his family in this time of deep bereavement be sent forward from the meeting.

Mr. LOWE seconded this proposal, and it was carried unanimously.

A vote of thanks to the chairman and directors closed the proceedings.

Petroleum Engine Company, Limited.

IN accordance with the notice issued to the shareholders, the meeting of this company was held last Friday at the Cannon Street Hotel, but when our representative attended he was refused admission. Upon a shareholder asking the reason of the non-attendance of the members of the Press, the Chairman said it was not usual to send notices to the Press, and if reporters did not attend it was not the fault of the company. We draw attention to this fact, as our reporter, along with others, was not permitted to enter the room in which the meeting was held. We are indebted to a shareholder for a few particulars relating to the meeting.

The CHAIRMAN (Mr. Pawson), in proposing the adoption of the report, attacked the circular which had been issued by Mr. Stovin. A letter had come to hand from Messrs. Priestman stating that the engine was being largely adopted, and they had received more orders between July and September of this year than they had during the whole of the previous year.

Mr. MCLAREN seconded the motion.

Mr. STOVIN proposed that an extraordinary general meeting be called for the purpose of considering the affairs of the company, as well as the report of the balance.

This was seconded by Mr. HOLLINGTON, but upon being put to the meeting the motion was lost. The original motion was then put to the meeting and adopted.

One or two important facts came into prominence during the meeting. Thus, Messrs. Priestman—although not supposed to have a monopoly—were sole licensees and manufacturers, and up to date the company had no power either to grant licenses or sub-licenses to enable anybody to manufacture.

The City of London Electric Lighting (Pioneer) Company, Limited.

AN extraordinary general meeting of the City of London Electric Lighting (Pioneer) Company, Limited, was held at Winchester House, Old Broad Street, E.C., on Wednesday last, the Lord Mayor (Sir Joseph Savory) presiding.

Notices had been sent to the shareholders, stating that the board had sold all the assets and valuable rights of the company to the new City of London Electric Lighting Company. The amount received from the new company would enable the directors to return to each shareholder of the Pioneer Company his original capital of £50 per share, with a bonus of £25, together £75 per share. The object for which the Pioneer Company was originally formed, viz., the formation of a company to undertake the electric lighting of the City of London, has thus been successfully accomplished.

The notice convening the meeting, which was read by the secretary, stated that the meeting was held for the purpose of considering, and, if thought fit, passing a resolution: "That the company be wound up voluntarily."

The CHAIRMAN then said: Gentlemen—You will have heard from our notice, which has been read by the secretary, the object for which this meeting is summoned. It is my duty to tell you that the object for which this company was formed has now been realised, and we have sold the concern to the City of London Electric Lighting Company for the sum of £75,000, clear of all deductions. I think this must be, and will be, satisfactory to the body of shareholders, and I have no doubt that you will unanimously pass the resolution which it is intended to place before you to-day. Any question that any shareholder may like to ask I shall be very happy to answer. He then formally proposed that the company be wound up voluntarily.

This was seconded by Mr. BRAITHWAITE, who stated that the object for which the Pioneer Company was formed, as stated in their prospectus, had been obtained with a bonus of 50 per cent. on the money the shareholders had embarked.

The resolution was then carried unanimously.

The CHAIRMAN stated that he had only now to add that the extraordinary general meeting would be held in about a fortnight, and the cheques for the shareholders would be made out as soon as possible after that meeting.

Mr. EDWARD LEE then proposed a vote of thanks to the Lord Mayor and his brother directors.

This was seconded by Mr. MACGEAGH, and carried unanimously.

The CHAIRMAN, in acknowleding the vote of thanks, stated that it was his firm resolution when he came into office as Lord Mayor not to join any public company, and it was only for very exceptional reasons, and through pressure brought on him from very high quarters, which induced him to so far waive his resolution and join that company. Itwas satisfaction to him that he was able to announce that the thing they had in hand had progressed so satisfactorily.

This terminated the proceedings.

The Eastern Telegraph Company, Limited.—It has been decided that payment be made on October 15th of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum, on the preference shares of the company for the quarter ending September 30th; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended June 30th. The register of transfers will be closed from the 7th to the 14th October, both days inclusive.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of the Anglo-American Telegraph Company, Limited, held on 25th ult., it was resolved to declare an interim dividend for the quarter ending September 30th, 1891, of 12s. 6d. per cent. on the ordinary stock, and £1 5s. per cent. on the preference stock, less income tax, payable on October 31st, to the stockholders registered on the books of the company on September 30th, 1891.

Callender's Bitumen Telegraph and Waterproof Company.—This company have declared an interim dividend of 5s. per share, payable on October 31st.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended September 25th, amounted to £4,915.

The City and South London Railway Company. Traffic receipts for the week ended September 27th, amounted to £708.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 25th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £3,883

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Sept. 24th.)	Closing Quotation. (Oct. 1st, 1891.)	Business done during week ending (Oct. 1st, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	49	48½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	86⅛— 87⅛	87 — 88	87⅜	86⅝
2,849,510*l*	Do. do. Deferred	Stock	13⅛— 14	13 — 13⅛	13⅛	13
130,000	Brazilian Submarine Telegraph, Limited	10	11⅝— 12¼	11⅜— 12¼	12⅛	11⅞
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102	99 —102	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛— 3⅜	3⅜— 3⅝	3½	3⅛
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 2⅛	1⅞— 2⅛	2 3/16	1 15/16
50,000	City and South London Railway, Nos. 1 to 50,000	10	2 — 4	2 — 4	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	122 —124	122 —124 xd	124	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	½	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5⅛	5 — 5⅛	5 5/16	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10⅛— 11½	11	10⅝
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3½— 4 xd	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9 — 10 xd	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅞— 11⅛	10⅞— 11⅛	11⅛	11
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜	14⅛— 14⅜	14⅜	14
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅝	15⅛
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	109½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	15 1/16
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	106 —109	106 —109	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6 — 6½	6 — 6½	6 1/16	6
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3 — 3¼	3 — 3¼	3⅛	3
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3⅞— 4⅛	4 — 4¼	4 1/16	3 15/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	2¼— 2⅜	2¼— 2⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞	9⅞	9 11/16
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15	14 13/16
150,000	Great Northern Tel. Company of Copenhagen	10	18⅞— 19¼	18⅞— 19½	18 13/16	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	20 — 21	20 — 21	20⅜	20
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7⅞— 8⅛	7 — 8	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9⅜	9 — 9½	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7⅛	6⅞— 7⅛	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	106½	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	10 — 10⅛	10 — 10⅛	10⅜	10 3/16
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4 5/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	12½	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12½— 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	106 —107	106 —107	106⅜	106⅛
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000*l*	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅞— 8⅛	8 — 8½	8⅜	7⅞
7,900	Do. do. do. 7 per cent. pref.	2	4⅜— 5⅛	6¾— 7⅛	4⅝	...
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	5 — 5½	5 — 5½	5⅜	5 1/16
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42⅝
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures, ...	100	96 — 99	96 — 99	...	...
30,000	West Coast of America Telegraph, Limited	10	3¾— 4¼	3¾— 4¼	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	98 — 103	98 —103	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10⅜— 11¼	10⅜— 11¼	11 1/16	...
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6 15/16	6⅝
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4¼— 4⅜	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105	102 —105	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105	102 —105	104½	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	1⅞	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½— 10	9½— 10	9 15/16	9⅞
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	120 —125	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅝— 6¼	5⅞— 6⅛	6 1/16	5⅞

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Ordinary of £10 each, £4 paid, 4—4½.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem. fully paid, 1—1¼.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4½—5.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅝—1¾.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅜ — ⅝.—National Telephone Debentures, 2½ — 3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅛—2⅜.—£5 Preference, fully paid 3¾—4.—Debentures 90—95.—Wards Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT.—3 per cent. (September 24th, 1891).

THE DYNAMOS AT FRANKFORT EXHIBITION.

By W. B. ESSON.

II.

By the side of the large direct-current dynamo described in last article, Messrs. Siemens and Halske exhibit the direct driven alternator shown in fig. 3. This gives a maximum output of 330 kilowatts at 100 revolutions per minute, the current being 165 amperes and the difference of potential 2,000 volts. The armature is a fixed ring with its coils wound Gramme fashion, while the magnets, corresponding in number with the fixed coils, project radially from a central wheel. The armature ring is formed by placing end to end 60 separate segments, each consisting of a number of channel-shaped soft iron plates laid together and wound with 20 convolutions of a stranded conductor. The conductor is pressed up square, and its separate strands are insulated with varnish to avoid the formation of parasitic currents. The 60 segments being placed end to end they form a laminated soft iron ring about 460 cm. diameter and 50 cm. wide, having 60 coils wound on its tangential part and 60 teeth projecting inwards between the coils. Two stiff ring castings carry the segments, and any one of these may be removed for examination or repairs without disturbing the others. The radial magnets are also laminated, and are each wound with a magnetising coil having 56 convolutions. A current of 56 amperes is required to excite the machine, this being

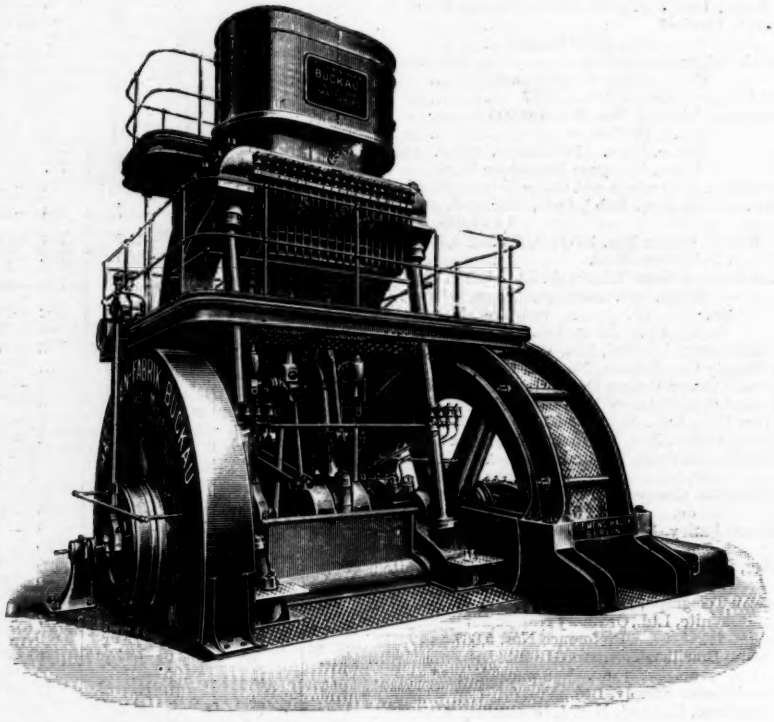


FIG. 3.

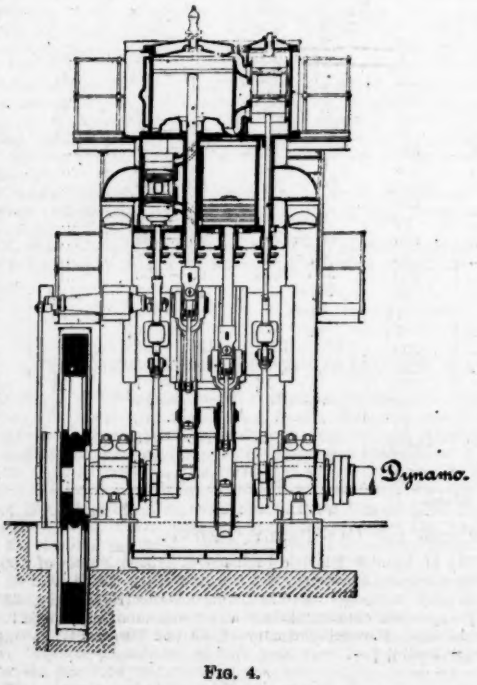


FIG. 4.

furnished at a potential of 70 volts by an interior pole direct-current dynamo. The energy required for excitation is therefore something under 1¼ per cent. of the output. The magnet wheel measures over the tips of the radial cores 370

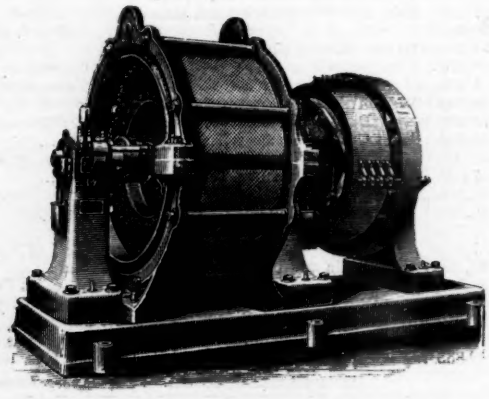


FIG. 5.

cm. in diameter, the central part being a massive casting, as shown, with six arms. This is driven by a compound condensing engine manufactured by the Maschinen Fabrik Buckau, of Magdeburg, having cylinders 62·5 cm. and 95 cm. diameter, and a stroke of 70 cm. The

engine is remarkable on account of the novel arrangement of its cylinders, shown in section by fig. 4. The low pressure cylinder is placed above the high pressure, and to the left, just far enough to allow the low pressure piston rod to come outside the walls of the high pressure cylinder. By this arrangement the centre lines of the cylinders are brought much closer together than is possible with the usual side by side design, and steadier running is consequently secured. The cranks are set opposite, and the weight of the moving parts is the same on both high and low pressure pins. The makers claim that, resulting from the parts being thus balanced, and the proximity of the cranks rendering the centrifugal couple very small, a higher speed is attainable with this engine than with those having side by side cylinders. Though running at 100 revolutions per minute at the exhibition, the normal speed of the engine is 130, corresponding to a piston speed of about 3 metres per second. The admission of the steam is regulated by piston valves, the whole arrangement of cylinders and valves being very compact, and the design generally carried out to economise floor space as much as possible. The crank shaft is of Martin steel, and the bearings are of white metal, run into cast steel blocks. The bedplate reaches right to the dynamo, the ring castings which carry the armature segments forming with it a stiff framework which carries the outer bearing, and from which project strong brackets, as shown, to furnish a good spread for the dynamo foundation.

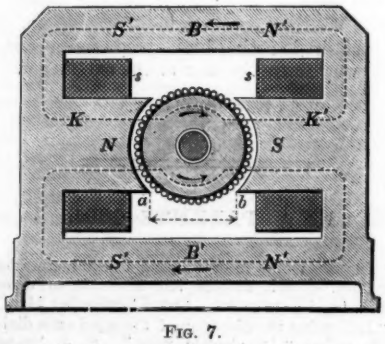


Fig. 7.

Several motor-dynamos are to be found at Messrs. Siemens and Halske's exhibit. One of these is shown in fig. 5, and consists of an alternating current motor coupled direct to a four-pole interior magnet dynamo, the motor being supplied with current at 2,000 volts, and the dynamo giving a current of 660 ampères at 150 volts. This combination runs at a speed of 250 revolutions per minute, and is employed to charge a battery of storage cells. The motor is similar in construction to the large dynamo just described, and it is started by allowing a current from the cells to flow through the dynamo. The latter acts for the time being as a motor, and quickly brings the machine to its synchronising speed. Two smaller machines of the same type are also exhibited.

Two motor-dynamos*, each consisting of two drum armatures mounted on one shaft and running in a couple of two-pole fields, are to be seen at work. If the reader imagines that two of the vertical pattern dynamos, shown in fig. 2 a fortnight ago, are placed end to end, he will get a very good

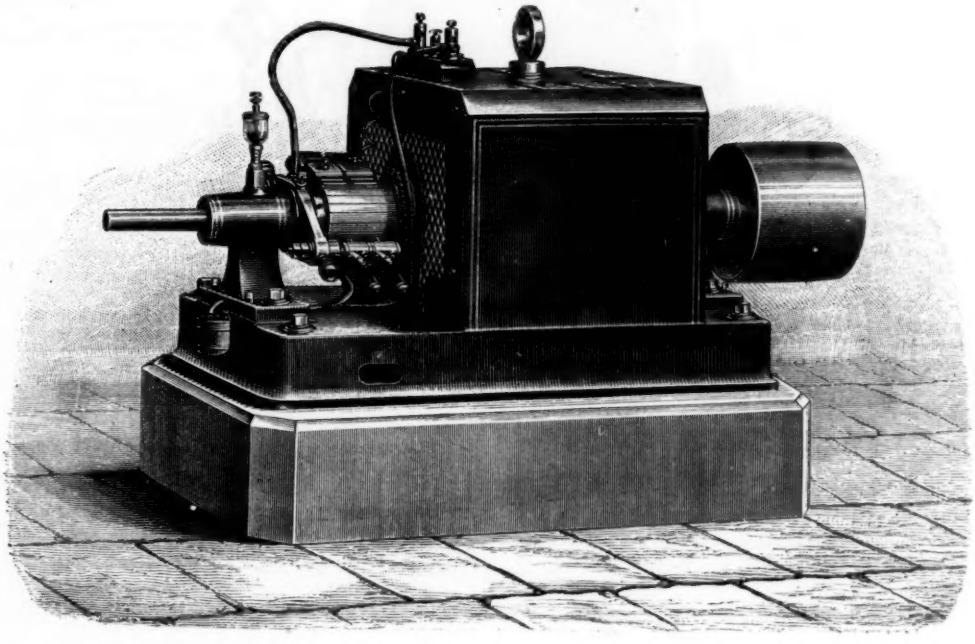


Fig 6.

idea of these machines, the only difference between the design he pictures and the actual thing being that in the latter the magnets for both armatures are cast on one long bed-plate. But they are virtually a pair of drum machines of the pattern illustrated coupled together, one acting as motor and the other as dynamo. The motor receives current at 150 volts from the large direct-current machine described in last article, while the dynamo gives a current of 100 ampères at a pressure of 300 volts. Several small direct-current motors are exhibited, suitable for driving fans or other small machinery, while an interesting collection of search light appliances is also to be seen. As a description of these lies outside the scope of the present article, they may be dismissed with the remark that this firm employs the horizontal arc lamp for projectors, as do several others manufacturing similar apparatus.

Near the exhibit of Messrs. Siemens and Halske is that of Messrs. Garbe, Lahmeyer & Co., of Aachen. This firm constructs dynamos and motors up to 100 horse-power, and several good examples of their two- and four-pole machines are shown. The frame and magnets are in these machines cast in one piece, and the design is of a very substantial character. The armatures are all of the drum type, the cores being formed of iron discs separated by paper, and the conductors lying in Pacinotti grooves, running lengthways, but not quite parallel to the shaft. A two-pole machine, giving 270 ampères and 65 volts at 1,000 revolutions per minute, is shown in figs. 6 and 7, a single casting, it will be observed, serving to form magnets, yoke and bedplate. The only ob-

* To the motor-dynamo has been applied by some the singularly inappropriate and misleading term of "dynamotor." The machine described is simply a motor-driven dynamo, and if life is so very short as to render abbreviations everywhere necessary, it is just as well to let the contraction give a hint, where possible, of what is contracted.

jection to this form of magnet is that the yokes have to be of considerable length; but as a set off against this, the advantage of a perfectly uniform distribution of the field lines must not be lost sight of. The machine is belt-driven by a vertical engine, and a second pulley on its shaft transmits power to an auxiliary dynamo, giving about 25 volts, which is thrown into action when it is desired to charge accumulators. A two-pole motor, of design similar to the dynamo in fig. 6, is driving the mill of Gebrüder Seck, in the Werkstatt-

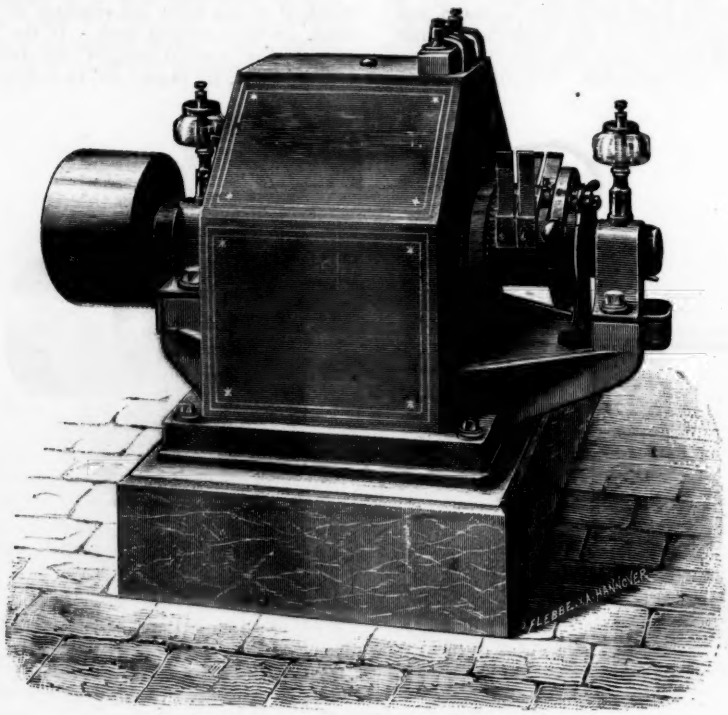


FIG. 8.

Halle. This gives 12 H.P. at 650 revolutions per minute, and is shunt-wound. On the top of its frame is mounted a neat case, containing a resistance which may be gradually inserted in or taken out of the shunt circuit by a handwheel, for the purpose of speed regulation.

The largest machine shown by Messrs. Garbe, Lahmeyer

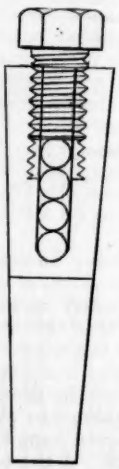


FIG. 9.

and Co. is of the four-pole type, giving 58 kilowatts, at a speed of 500 revolutions per minute. The current is 500 amperes, and the difference of potential 116 volts. An exterior view of the machine is given in fig. 8, but the outside casing prevents one from seeing quite clearly the arrangement of the magnets. These lie diagonally, and project radially towards the armature from a heavy octagonal yoke ring with which they are cast. The commutator segments are insulated from each other by vulcanised fibre, and the wires are connected to the segments by screws. Fig. 9 shows the method of fastening. Projecting from the segment is a lug, which has a slot in it wide enough to receive the wires, in this machine four deep. The binding screw, one to each segment, clinches the wires as shown, its diameter being, roughly, twice the width of the slot, so that there may be enough thread at the sides to give it a good hold.

The fashion of securing the conductors to the commutator by screws constitutes one of the features of German machines. Solder is employed only when, owing to there being a large number of segments, screws cannot be used. In interior pole machines without commutators soldering has of course to be done, as under the circumstances screw fastenings are precluded, but in all other cases screws are used wherever possible.

Messrs. Garbe, Lahmeyer & Co., show a four-pole machine giving 28,000 watts at 350 revolutions per minute, directly coupled to a Westinghouse engine, for ship lighting, this combination of single-acting high speed engine and dynamo being one of very few to be seen at the exhibition.

(To be continued.)

NEW PATENTS—1891.

15,522. "Improvements in or relating to conductors for dynamo-electric machines, electric motors, and alternate or direct current transformers." G. B. LUCKHOFF. Dated September 14th.

15,529. "Indicating the direction of the wind on a dial by means of electricity, called "An electric vane." E. J. STARR. Dated September 14th.

15,542. "Improvements in telephones." D. URQUHART. (Communicated by L. H. Despeissis, France.) Dated September 14th.

15,575. "Improvements in galvanic batteries." A. DE MERITENS. Dated September 14th.

15,579. "An improved arrangement of automatic electric switch and cut-out for use in charging secondary cells and for similar purposes." O. MARCH. Dated September 14th.

15,597. "An improved battery." C. U. FISHER. (Communicated by R. H. Thompson, United States.) Dated September 15th. *(Complete.)*

15,621. "Improvements in the method of making the plates or elements of a secondary or storage battery." S. C. C. CURRIE. Dated September 15th. (*Complete.*)

15,645. "Improvements in and relating to ceiling blocks or roses and cut-outs for use in connection with electric light and other circuits." E. T. GREENFIELD and C. J. KINTNER. Dated September 15th. (*Complete.*)

15,697. "Improvements in electric telephonic transmitters." J. GRAHAM. Dated September 16th.

15,705. "Electric signalling on railways to trains in motion or otherwise." J. WATKINSON and G. PRINCE. Dated September 16th.

15,749. "Improvements in electric arc lamps." W. H. AKESTER. Dated September 17th.

15,768. "Improvements in the method of and apparatus for distributing electricity." C. J. HALL. Dated September 17th.

15,782. "Improvements in alloying aluminium with other metals." G. L. ADDENBROOKE. Dated September 17th.

15,794. "Improvements in electric arc lamps." F. W. DICKINSON. Dated September 17th.

15,834. "Improvement for carriers for conical shades for electric or other lamps." B. M. DRAKE and J. M. GORHAM. Dated September 18th.

15,849. "Improvements in telephonic instruments." A. T. COLLIER. Dated September 18th.

15,868. "Improvements in electric arc lamps." H. HEGNER and L. LENCZEWSKI. Dated September 18th.

15,872. "Improvements connected with electric motors and elevators." THE AMERICAN ELEVATOR COMPANY. (Communicated by Otis Bros. & Co., United States.) Dated September 18th.

15,882. "An improved switch holder for incandescent electric lamps." H. HEARTFIELD. Dated September 19th.

15,922. "Improvements in electrical incandescent lamps." R. HADDAN. (Communicated by G. Dedreux, Germany.) Dated September 19th.

15,937. "Improvements in electrical measuring instruments." J. C. FELL. (Communicated by E. Weston, United States.) Dated September 19th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

7219. "An electric supply meter." J. PERRY. Dated May 9th. 8d. In one form of the invention a tubular magnet has poles which are concentric cylindric surfaces. A concentric cylindric vessel of copper rotates in the space between the poles, being attached to a spindle driving a train of wheels connected to a counter at its upper end. An insulated copper ring lying at the bottom of the space which forms a circular trough is connected with the supply conductor. Mercury fills the space lying both inside and outside the copper vessel which is completely immersed, only the spindle passing out of the surface of the mercury. A cover is provided, confining all the outer parts of the upper surface of the mercury so that its free surface is merely at a central opening where the spindle passes. Care is taken to prevent the mercury getting into the winding of the magnet at the bottom. Current comes from the bottom copper ring through the mercury to the lower edge of the copper cylindric vessel; it passes vertically along the vessel all round and leaves the vessel at its upper cylindric edge or by a flat end, and passes through the mercury to some fixed circular conductor which the mercury touches, such as another ring of copper or a bright part of the iron of the magnet. All other parts of the magnet, and indeed, of the copper vessel except at the top and bottom, are covered with insulating material, preventing the mercury from making electric contact anywhere except at the bottom and top, and none of the supply current flows except through the mercury and the copper vessel. The copper vessel rotates because it is conveying current and is in a magnetic field, the direction of the current not being the same as that of the magnetic induction. One or both of the cylindric poles has a number of gaps in it filled up with plaster of paris or other suitable material, so that in the cylindric space the strength of the magnetic field varies greatly, and hence the resistance to motion is mainly due to Foucault currents. 8 claims.

9,904. "Improvements in armatures for electrical apparatus such as dynamos, motors and transformers." W. H. CLARKE. Dated June 26th. 8d. The armature core is built up of thin sheet iron discs, each formed with a number of radial slots and mounted or threaded on a bush of insulating material secured to the armature spindle. This bush has a spiral keyway or featherway cut in it to form part of a screw thread, that may take about two-thirds of a turn in the length of the armature. Each of the discs is provided with a key or feather adapted to fit in the keyway or featherway in the bush. In some cases the keyway or featherway may be made straight. To the spindle at one end of the armature is keyed a plate that carries a number of flattened tubes equal in number to that of the radial slots in the armature. These tubes enter the slots in the armature core and pass through the plate terminating at their outer ends in a specially shaped funnel or mouth piece. The arrangement is such that when the armature revolves, air is caught in the funnels and driven in a continuous stream through the slots in the core of the armature, thus effecting thorough ventilation thereof. At the end of the armature opposite to that at which the tubes are located, openings are left between the wire coils for the escape of air passing through the armature. The armature coils are wound in wide, shallow grooves cut in the plates forming the core. These grooves are parallel with the axis of the armature, and may be cut after the core is built up. 2 claims.

10,316. "Improvements in electric safety fuses and in electric switches." J. D. FINNEY ANDREWS. Dated July 3rd. 6d. The inventor provides a base of incombustible insulating material, which may be a disc or of other form, and in this base he forms a groove or hole to receive a length of fusible wire. In the base he forms two holes, extending down from the face of the base into its body, but not through it, and opening into the groove or hole, in which is placed the fusible wire, with its ends extending into the two holes. He pours into the holes fusible metal or alloy, so as to form two conducting plugs cast on to the fusible wire. To these plugs he connects the circuit wire when the fuse is to be used alone; or, when it is to be used in conjunction with a switch, he makes the fuse above described act as the base of the switch presenting the two plugs for contact with the movable part of the switch; or he makes the fuse itself the movable part, its two plugs being moved to or from fixed contacts. 2 claims.

10,741. "Improvements in incandescence bodies for electric glow lamps." SIEMENS BROS. & CO., LTD. (Communicated from abroad by the firm of Siemens and Halske; of Berlin.) Dated July 10th. 6d. This invention relates to improvements in the production of incandescence bodies for electric glow lamps, whereby a core consisting of an incandescence body, such as a carbon filament or rod, is covered with a coating of a refractory material, consisting of refractory metallic carbides, nitrides, phosphides, and sulphides, as also combinations of the refractory metalloids, silicon and boron, with refractory metals, or with various compounds of the said bodies. 3 claims.

10,742. "Improvements in incandescence bodies for electric glow lamps." SIEMENS BROS. & CO., LTD. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 10th. 4d. Relates to improvements in the production of incandescence bodies for electric glow lamps whereby the filaments (especially carbon filaments) are coated with a solid covering of a material that will not melt at the temperature of incandescence, and that will prevent the carbon filament from disintegration. The materials which are more particularly suited for this purpose are silicon nitride and boron nitride, which bodies are stable at the highest temperatures, do not lose any nitrogen and do not take up oxygen, so that an incandescence body coated therewith can, under certain circumstances, also be made to operate in the presence of air. 2 claims.

10,743. "Improvements in the means for effecting conducting connection between overhead conductors on electrical railways and tramways and the electrical apparatus on the vehicles." SIEMENS BROS. and CO., LTD. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 10th. 8d. Consists in supporting the arms carrying the sliding contacts from the axle boxes of the vehicle instead of from the body, so that as the distance between the axle boxes and the overhead conductor does not vary, proper contact between the latter and the sliding contacts will always be maintained. 4 claims.

10,806. "Improved underground conduit system for electrical distribution." B. J. B. MILLS. (A communication from abroad by E. T. Greenfield, of New York.) Dated July 11th. 1s. 1d. The casing or conduit for the electrical conductors is laid in sections. Each section includes a trough, preferably rectangular in cross section, formed preferably of wood treated with a water proofing and preserving material. Within this trough the wire ways are formed. These wire ways are formed of compound tubes possessing high insulating properties. Each of these tubes is made by combining a formed base of animal, vegetable or mineral porous, fibrous material, with a filling of a bituminous compound, in such a manner that the basis and filling material become a homogeneous tube, which will be dense and hard and possess high insulating properties, and be unaffected by ordinary thermal or hygrometric changes. 17 claims.

12,383. "Improvements relating to electric lamps and to apparatus connected therewith." A. L. SHEPARD. Dated August 7th. 8d. An important feature of the invention consists in providing, in combination with the lamp circuit, a lamp whose regulation is controlled by a coil or coils in the main circuit, so that while keeping the current constant, it will take up or absorb in its arc any excess of potential, or compensate for diminution of potential below the normal; the remainder of the lamps, being regulated by coils shunted on their own arcs, are thus protected from the effects of such variation of potential. 3 claims.

13,463. "Improvements in and connected with zincs for galvanic batteries." J. MOSELEY. Dated August 27th. 8d. The inventor constructs each zinc of a series of sheets or layers of wrought or rolled sheet zinc, or of drawn zinc tubes. 4 claims.

21,043. "Improvements in telegraphic apparatus." S. VAN BUREN ESSICK. Dated December 24th. 11d. Relates particularly to improvements in printing telegraphs of the page type, in which the message is printed upon a page or sheet of paper, after the manner of a type-writer, and its objects are:—1. To devise a receiving apparatus in which the paper carriage shall be positively propelled through the agency of a spring or weight impelled mechanism. 2. To provide improved means for returning the paper carriage to its normal position at any portion of its forward advancement, thereby avoiding the necessity of advancing said carriage to its extreme limit before it is returned to its normal position. 3. To cause the printing to be effected through the agency of power impelled mechanism, controlled by an escapement. 4. To provide a transmitter and circuit connections adapted to actuate and control the receiving apparatus. 5. The general accomplishment of the several functions attributed to the entire mechanism described. 14 claims.

CORRESPONDENCE.

The Lighting of Railway Trains Electrically.

I regret that in your leader of September 18th, in which you criticise a paper I wrote, and which was read before the British Association at Cardiff recently, you show a complete ignorance of the working of electricity and how to deal with it to get efficiency and economy under varying conditions.

There are a number of absolutely false statements in your article, and therefore I beg to enclose you a correct abstract of the paper which, with the calculations you inserted in your last week's issue, make the matter clear.

Your assertion

that 20 amps. × 50 volts
and 50 amps. × 20 „

are the same thing, shows that you have learnt only part of a formulæ, and that you have no experience whatever, as you fail to see that W represents total work done. You do not account for the *extra loss* caused by using low voltage lamps.

Your other assertion about the "solid" and "well thought out" work done on certain railways is unfortunate, as the results, which you are evidently ignorant of, prove. I have fitted very many thousands of pounds worth of trains which are working successfully, and they are being maintained economically. My paper gives the results of such working, and is not, as you infer, theoretical.

I. A. Timmis.

September 28th, 1891.

P.S.—Mr. Crookes's letter of 21st inst. :—

1. I give 8 C.P. as my auxiliary light, and have it at work in a number of trains.

2. Central station lighting, *i.e.*, charging, is very economical on a short railway. I have a complete railway equipped thus.

3. Central station charging, or axle-driven dynamos or special engines and dynamos, are each and all working with my auxiliary system. I. A. T.

The main conditions that are necessary are :—

1. Every carriage must carry its own store of electricity—*i.e.*, a battery. This battery must be light—say, less than 1 cwt.

No carriage must be detained at any time to change its battery.

2. High voltage lamps must be used to give a brilliant light and economise the current used.

The system described in the paper can be, and is, used with—(i.) A dynamo driven from an axle, or (ii.) a dynamo and special engine on the locomotive; (iii.) central charging stations.

In the first and last cases it is necessary to have a large battery in the guard's van.

Whatever the main source of electricity may be, it supplies the current at a high voltage (say 50) to light a main system of lamps through the train. But as any carriage may be attached at a station to be recoupled on to another train, or break loose, or be slipped from a train, it is absolutely necessary to have a storage or battery of accumulators in each carriage. The cost and weight of batteries in each vehicle, with electromotive force enough to light the main lamps (say 50 volts), makes them impossible. Further than this, it would be impracticable to charge them. We therefore put another system of small lamps, six or eight volts, and three or four small cells, in each vehicle to light them. These small batteries we charge from the main source of electricity on the train, and thus they are no trouble—small weight and small cost. The working of these two systems, main and auxiliary, is under the control of the guard while the train is complete; but should any vehicle become detached from the main circuit, the auxiliary lamps automatically light up. If, also, anything happen to the main source of electricity, the auxiliary system can be put either under the control of the guard, or be fitted to come into action automatically.

The placing of the main leads through each vehicle, and the couplers used, are fully described in the paper.

We sometimes use four through leads and sometimes only two. The circumstances of the case determine how many through leads are necessary, and also what the main source of electricity must be.

In every case, however (except in omnibus trains), we use the double system of main and auxiliary lamps, with main and auxiliary supply of electricity.

[We insert with pleasure Mr. Timmis's courteous letter, and we gladly place at his disposal the space of which he desires to avail himself for the further explanation of his "system." We render to him our hearty thanks for his sympathy in our ignorance of the "working of electricity." It is at all times a pleasure to bow to recognised authorities, but, nevertheless, in the present instance, we must ask Mr. Timmis to allow us to adhere to our expressed views. We quite recognise the fact that we have studied under different masters, and probably in different schools. We repeat that the energy absorbed by an incandescent lamp is usually calculated by the *watt*, and that, for the purpose under consideration, there is no difference in the consumption of power whether a 50 volt, or a 35-volt lamp is employed. We do not say there is no economy in other directions in employing a high rather than a low-pressure lamp; but what we do say is that the great advantage spoken of by Mr. Timmis, as applied to the two voltages quoted, does not exist. Mr. Timmis's letter would appear to be drafted upon the same lines as his paper. Bare statements, wholly unsupported by data, will not carry conviction. Whatever Mr. Timmis may have accomplished abroad it will scarcely affect what has been done, or is being done, in England. We have no knowledge of the results secured by him in foreign countries, and his paper gives no data in this direction. The courteous tone in which his letter is couched prompts us to believe he will pardon us if we observe that the fact of his having spent "many thousands of pounds" in fitting up trains with the electric light, will not convince others that he has a greater knowledge of the subject, or that the various methods advocated by him are more economical, more simple, or more reliable than those which have been put in operation in England. Would Mr. Timmis object to name the "complete railway" equipped for central station lighting referred to in paragraph 2 of his P.S. A description of it would, we feel sure, prove interesting to many of our readers.—EDS. ELEC. REV.].

Alternating Current Arc Lamps.

I should be glad to hear from any reader of the REVIEW the reason why in alternating current arc lamps the arc travels round and round the carbons all the time the lamp is burning? The direction usually appears to be from left to right; this is a peculiarity I have not seen noticed before.

E. I. C.

September 29th, 1891.

Transformer Losses.

I am sure many of your readers will have been delighted with the short paper by Mr. Rider on the above subject in the current number of the REVIEW.

When, some few months ago, Prof. Ayrton and Mr. Mordey published the results of independent experiments on the losses in transformers, everybody was forced to conclude that some phenomenon had taken place, or that the laws of nature had been suspended on behalf of the experimenters. All such persons will now be very glad to learn that the laws of nature are still in undisturbed operation, and that there is no more any reason to believe that a piece of iron, subjected to greater forces, behaves as though no force is acting on it at all. For, if we consider what these losses in the iron of a transformer are, we shall see that it is impossible to expect anything but an *increase* of iron loss at full output, as shown in Mr. Rider's experiments. At no output, the magnetic force acting on the core of a transformer may be called x. At full output, the magnetic force may be called

$$a + x - a,$$

where $a + x$ is the force due to the ampère-turns of the primary coil, and $-a$ is the force due to the ampère-turns of the secondary coil. Here a and $-a$ appear to neutralise one another, and it is difficult to believe that they can do otherwise. Consequently the magnetising force acting on the core will be x, and the hysteresis loss must be proportional to x, and is constant, since x is constant.

But there is another loss which, however small it may be, is, nevertheless, always present, viz., that due to Foucault currents in the iron core. Now this loss is, of course, $a\ C^2\ R$

loss, and since the iron core is at a higher temperature at full output than at no output, R at full output, and consequently C^2 R, will be greater than at no output.

Samuel Joyce.

September 27th, 1891.

The Telephoning of Great Cities.

Owing to my absence from England, your criticism of September 11th on my British Association paper has only just come to my notice.

As you surmise, I do not object to criticism, and when I wrote the paper, knew fully well that its contents would not meet with approval in certain interested quarters, and that it would be sure to encounter rough handling.

You very pertinently observe, in effect, that special knowledge, ripe experience, careful study and familiarity with the latest developments are necessary in those venturing to discuss the problem of how to telephone great cities, and express on my behalf a solicitude respecting my lack of experience, which must appear somewhat far-fetched to those who know the history of my connection with the old National Telephone Company. It would be interesting to enquire how far the qualifications and practical telephonic experience of your critic entitle him to assume the position which he declares to be such an onerous one. An Editor or member of the REVIEW staff, however well posted in general, could not possibly be such a specialist as is described. If not a member of the REVIEW staff, then your critic must be, supposing he is a *bona fide* telephonist (and if he is not, his opinion, according to his own showing, is worthless), either a Post-office electrician, or one owing allegiance to the National Telephone Company. A Post-office engineer would not make the palpable mistake of saying, as your critic does, that Paris, Brussels, and other continental towns would have to be reconstructed according to Mann's system, in order that London subscribers might communicate with them. The merest telephonic tyro could correct your critic there. Besides, the Post-office possess no large exchanges, and the practical study you declare to be necessary, could not, consequently, be acquired by a Post-office official. The resulting inference is natural and inevitable. Your criticism, if not actually written, was, undoubtedly, inspired by someone interested in the National Telephone Company, and is, consequently, as a criticism, worthless, because the system I advocate is one that the Company cannot possibly adopt, without sacrificing nearly the whole of its existing plant, and because that Company, acting on the advice of certain, not all, by any means, of its electricians, has recently spent, and is still spending, many thousands of pounds in concentrating its wires at a few Central Exchanges. Although this concentration has not improved the service, either in London or the other towns where it is being practised, it would be too much to expect that the National Company would refrain from criticising, adversely and bitterly, any plan so essentially different from its own, as mine is. The article bears internal evidence of its origin. Some years ago, the excellent results yielded by the Mann system in Dundee and elsewhere, were brought to the notice of the late United Telephone Company. Mr. J. B. Morgan, on behalf of that Company, raised several objections to the system, which were identical with those set forth in your article. One of Mr. Morgan's greatest objections, and one which excited special remark, because it had not previously been heard of, was the possibility of the nature of a subscriber's business becoming suspected by a competitor overhearing the numbers he asked for on the service wire. Such a difficulty had never arisen in practice, and the objection was lost sight of, until now revived by your contributor, who also shares another of Morgan's pet delusions—that the Law and Mann systems are identical. Although it seems plain from these considerations that your article must be credited to one of Mr. Morgan's disciples, I have no objection (your space is my only care) to answer it.

Much is made of the supposed identity of the Law and the Mann systems, a question which has really no bearing on the main subject. Mr. Mann has always affirmed that his invention was independent of the Law, and I see no reason why it should not have been. Certainly it was in practical use in Great Britain before the Law. The real point is that, in spite of the supposed identity, the Mann is a highly practical and successful system and the Law is not. An Atlantic liner and a coal barge are both vessels designed to float in water, but few will maintain that there is no difference between them.

Your critic says that "the signal (annunciator) system may be called universal; the circuit wire system is characteristically American." What nonsense is this! The first telephone switch-boards ever seen and used in Europe were brought from America and *all* had annunciators, practically of the same pattern as is used by the National Telephone Company to-day. All European annunciator boards are consequently copies or modifications of the American idea. On the other hand, the Mann system, without annunciators, was in use in Great Britain before the Law. Your critic's comparison of telegraph instruments joined in series on an American district line with the Mann service wire is amazing. Telegraph instruments were joined in series on the same wire by Cooke and Wheatstone, by C. V. Walker on the South Eastern Railway, and by many others, certainly a quarter of a century before such an institution as a telephone exchange was dreamed of. If there is any sense at all in your critic's comparison then Cooke and Wheatstone must be credited with the invention of both the Law and the Mann systems, characteristically American as they are! This haziness about systems is in reality a very proper measure of your critic's general accuracy.

I am assumed to have inferred that the working of a town by means of several switch-rooms is new; of course, I did nothing of the kind. In 1883 Glasgow was laid out for seven switch-rooms on my recommendation, and London and Paris were divided before that. But I knew that owing to trouble and delay caused by faulty and complicated apparatus the tendency is now to concentrate as much as possible, in spite of the immense outlay involved; I also knew that there must be a limit to such concentration, and I endeavoured to show, as the result of my prolonged practical experience, that not only was it not necessary, but could be positively dispensed with, both with advantage and economy. It is satisfactory to know that except in the opinion of the National Telephone Company and the ELECTRICAL REVIEW I am generally deemed to have succeeded.

It should be clearly understood that I do not advocate splitting into small areas because of any special virtue inherent in that plan. My point is that continued concentration is impossible in the nature of things (we are only in 1891, and the telephone is only 14 years old), and that, consequently, any complete plan must anticipate and prevent by its natural operation the inevitable tendency to congestion which must develop as years roll on. The considerations which must determine the ultimate system are the number of subscribers that can be operated under one roof, and economy in running the wires. Both these set a limit on concentration. It is little use saying that 10,000 or 20,000 subscribers can be dealt with on one table (as a matter of fact, on the American system, they can't), if the subscribers' lines are so long and costly that high rates must be charged in order that the system may pay. Your contributor states that exchanges of 5,000 and 6,000 subscribers are now managed with ease. If he had said with difficulty, and at the cost of great dissatisfaction, he would have been nearer the mark. I understand that an attempt in America to work 10,000 on one table had to be abandoned.

I was made aware, just before my paper was read, that General Webber had proposed some years ago the dividing up of a town into numerous small sections, and I was careful to refer to the fact in the discussion. But unless General Webber's scheme included some plan for avoiding the linking in of electro-magnets, and for facilitating communication between the switch-rooms, it was not, with all deference to him, an adequate one.

I am twitted with differing from all other telephone engineers and managers. This is not true. Several of the best men in the employ of the National Telephone Company are in complete agreement with me on this subject, although they dare not say so; and a few days since I received a letter from the chief engineer of another British company expressing acquiescence in my proposals and estimates. But even if it had been my fortune to stand alone, the position would not have been either a novel or a hopeless one. When my telephonic translator was proposed in 1881, it was

laughed at by Mr. Morgan and the other wiseacres of the period, and yet it proved to be the only solution of the trunk line difficulty, and is now being extensively used by the National Telephone Company to improve their London service. In 1883 when I designed the system of over-house construction, now being copied in London, I had not a single believer in it outside my own staff. Reams of foolscap were written to show that it was unscientific, impracticable, and dangerous. The light wire would break and blow into contact, the arms would turn on the tubes, and the tubes in their chairs; the abolition of the double shackles would lead to innumerable accidents to passengers, and so on. Yet its use has now become universal; and is relied upon (very foolishly) to cure the defects of the London system, and some of the men who were originally its bitterest opponents are now engaged in fitting it up in London. It was the early adoption of this system which enabled the old National Telephone Company to show better financial results than the United or the Lancashire and Cheshire Companies, and which made the Scottish exchanges the models for the whole country. So, even, if my isolation were true, which it it is not, I should not feel very uncomfortable. The experience of the translator and over-house system will, I have no doubt, be repeated on the present occasion. Hostility first, imitation afterwards.

Your critic finds fault with my comparison of the American and Mutual systems. I anticipated rigid scrutiny on this point, which, together with my desire to be strictly fair and impartial, induced me to request a well-known expert, one of the best theoretical, as well as practical, telephonists in Great Britain—Mr. Joseph Poole—who fitted up and subsequently had charge of for several years the largest and most complete and satisfactory multiple switch-room on the American principle in this country, to draw up for me a statement of the movements required to be made in establishing a connection on an American multiple board. He did so, and showed 11 separate movements as necessary. My anxiety not to overstate the case against the American, induced me to strike two of these out, and so the list of nine movements given in my paper was produced. I think I am entitled to claim that this procedure was more than fair, and to set Mr. Poole's opinion against that of your anonymous contributor, who, moreover, weakens his case by alleging that movements 2 and 4 on the American plan should be counted as one, since they are only equal to movement 2 on the Mutual plan. If an experienced man, he must know that movement 3, which comes between 2 and 4, renders them separate operations. This objection is, consequently, in the highest degree disingenuous and calculated to deceive. He finds great fault—as is perhaps natural on the part of an advocate of a demonstrably inferior system—with the method adopted in comparing. He considers it unscientific and unworthy of the B.A. to deal with the number of movements and take no account of their value. He apparently expected me to evolve a new unit for the occasion, derived from time, brain work, judgment, and manual exertion, as fundamentals! I simply followed, innocently, the only method I was acquainted with, which I considered, and still consider, fair; but the damage done is not irreparable, and I am willing to hark back and compare over again if he will provide the unit. The objection, which I have already referred to as having originated with Mr. Morgan, is illusory. Only a limited number of subscribers can hear each other's orders, and if any special reason for secrecy should exist a code could be used. Scotch business men are not indifferent to their interests, and during the nine years' existence of the Mann system in Scotland, and elsewhere, not a single complaint on this score has been made. When some of the Dundee subscribers were told of Morgan's superfine objection they laughed.

The remarks about the necessity of adopting the Mann system in Paris and Brussels, also, if communication with London is to be held, and the reference to railway gauges, betray great want of telephonic knowledge. Metallic circuits would alone be necessary—they already exist in Paris—entirely different methods of signalling being admissible in the two terminal towns. At present, Dundee, Perth, &c., fitted with Mann's system, talk with Glasgow, Edinburgh, and other towns which are still wrought with annunciators.

A want of acquaintance on my part with the "latest developments" is more than hinted. This suggests that some substantial progress has recently been made. Judging from the complaints about the London service made by the National Company's own shareholders at the recent general meeting, and from what one hears from the subscribers, these recent developments have not so far worked many miracles; but it is interesting to know that they exist, and I would suggest that your critic should enlighten me, in common with your other readers, by contributing an article, at as early a date as possible, describing these developments as minutely as he can. By so doing he would at least show that he possesses some practical knowledge of telephony, a point which, after the numerous errors he has committed in talking about the Law, Mann and annunciator systems, I consider is seriously open to doubt.

Your critic likewise regrets that I have lost such a good opportunity for propounding a practical scheme for telephoning great cities. Why not let my failure point the road to his success? Why not propound in your columns the great scheme he must have looming in his mind. It is unkind and unfair of him to destroy mine without having a better to substitute.

To notice briefly your contributor's minor assertions. He says, "Whilst the central is in one respect simplified, it (*sic*) is set off by the circuit wires and additional apparatus at subscriber's offices." This is not so; there is absolutely no comparison between the two expenses. Besides, he forgets that I do *without the service wire*. Again, "connections through many switch-rooms without the intervention of intermediate electro-magnets is common to both systems." This I deny. The Post Office use electro-magnets in derivation, as I did myself in Scotland for many years, and Mr. Poole did in Manchester, but the plan does not find favour with the National Telephone Company's present advisers (which is the main point), and is certainly not *common*. Your contributor admits that the service wire is of advantage between exchanges. If so, why not to subscribers too? The principle is the same, and the method of application identical. A quicker method of making connection than I propose is alluded to. This probably refers to the single-cord system, which, however, has faults of its own, and which I purposely ignored. It was one of the features of the original Law switchboard of 1881, so can scarcely be classed as one of the "most recent developments" of which I am assumed to be ignorant. Your critic states that the circuit wire has been fitted to numerous exchanges and subsequently abandoned. If he means the Law, I agree; if the Mann, I dissent. So far as I know, the Mann has only been abandoned in one instance, and the change to annunciators occasioned such dissatisfaction, and the service suffered such deterioration that the manager who recommended and carried out the alteration was, I am credibly informed, *dismissed the company's service* as his reward. The experience is similar everywhere. Subscribers who have once worked with the service wire decline to waste time and patience with annunciators.

I shall, if desired, be glad to explain in a future letter why the Mann system, although so successful in Scotland, was not adopted generally by the old National Telephone Company. Consideration for your space forbids me entering upon the subject to-day.

With reference to the discussion on Mr. Preece's and my paper, I should like to state that my reply, as well as the remarks made by Mr. Gavey and other members, were curtailed by the chairman insisting upon closing the discussion on the ground that the telephonic papers had already occupied nearly half the working day, while five or six others were down to be read. I had not, in fact, gone through a third of the notes I had taken when the closure was applied.

I have read the letter from Mr. H. Goodwin, which also appears in your September 11th issue, but as that gentleman seems to think that metallic circuits cease to behave as such when grouped in considerable numbers, and writes on the assumption that the Law and Mann systems are practically identical, I do not propose to answer him at length. I will simply assure him that he is mistaken in supposing that a break in a service wire cuts off from the exchange the subscribers lying beyond. He is not the only one, however, as I have shown, who has split upon these rocks and suffered shipwreck on these—may I say Goodwin?—sands.

A. R. Bennett.

September 24th.

[For reply to this letter see our leading pages.—EDS. E. R.]